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Multivariate analysis of school principals' technology leadership competencies, learning school environment and schools' social network structures

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VOORWOORD

Ik voltooi deze lange reis die ik begon aan de Universiteit van Marmara in 2011, en die in 2014 doorging aan de Universiteit Gent. Ik wil allereerst Prof. Dr. Münevver Ölçüm Çetin bedanken, mijn promotor in Turkije, die me altijd heeft gesteund in dit uitdagende proces. Zijn waardevolle steun heeft enorm bijgedragen aan dit proefschrift. In 2013 stuurde ik een e-mail over mijn publicaties en nam ik contact op met Prof. Dr. Ruben Vanderlinde, die me hielp met het opstarten van mijn doctoraat met onderzoeksbeurs aan de Universiteit Gent. Ik ben heel blij dat ik een 'kritische vriend' heb zoals jij. Tot slot wil ik İlknur Bilgin Banoğlu bedanken, de mooie moeder van mijn enige dochter die altijd bij me was in België en in Turkije tijdens het schrijven van dit proefschrift. Met haar aan mijn zijde kon ik alle moeilijkheden, geduld en liefde overwinnen. Ik hoop dat de sociale wetenschappen - en alle wetenschappelijke studies die op het gebied van sociale wetenschappen worden uitgevoerd -, inclusief dit proefschrift, zullen bijdragen tot het groter gemeenschappelijk geluk van de grote familie van mensen waarvan we lid zijn. Ik respecteer mijn lezers met mijn sterke overtuiging dat we samen een meer gelijkwaardige en eerlijke wereld zullen opbouwen in het licht van wetenschappelijk denken.

İstanbul, december 2019

Köksal Banoğlu

FOREWORD

I set out on a “journey” at Marmara University in 2011, extended its route to Ghent University in 2014, and now I am completing it here. At the outset, I owe my sincere thanks to my Turkish co-promoter Prof. Dr. Münevver Ölçüm Çetin, who always supported me throughout this long process by generously sharing her extensive knowledge. She made a valuable contribution to this dissertation. I would also like to state that it was a great honour to carry out my doctorate research under the supervision of my Flemish co-promoter Prof. Dr. Ruben Vanderlinde. The email I received from him in 2013 asking about my publications and the following research collaboration paved the way for me to attend the doctorate research in Ghent University on a scholarship. I am so glad I have you my “critical friend”! At last, I send my heartiest and most affectionate love to my beautiful wife, to the lovely mother of my daughter; because she has always stood by me during the tough times of thesis writing process in Belgium and Turkey with her patience, affection and angel-like watchfulness. I believe that the most promising feature of social sciences in general, and every scientific work -like this study- in particular lies in its contribution to humankind’s happiness. With my firm blief in a fairer and more equal society to be created in light of the scientific thought, I would like to express my greetings to the readers of this work.

İstanbul, December 2019

Köksal Banoğlu

ÖNSÖZ

2011 yılında Marmara Üniversitesi'nde başladığım, 2014 yılında Ghent Üniversitesi'nde devam ettiğim bu uzun yolculuğu bugün burada tamamlıyorum. Bu meşakkatli süreçte Türkiye'deki tez danışmanım olarak benden bilgi birikimini hiçbir zaman esirgemeyen Prof. Dr. Münevver Ölçüm Çetin'e teşekkürü öncelikle borç bilirim. Kendisinin değerli desteğinin bu tez çalışmasına katkısı çok büyüktür. 2013 yılında yayınlarımla ilgili bir e-mail göndererek benimle iletişime geçen ve sonrasındaki süreçte araştırma bursuyla Ghent Üniversitesi'nde doktoraya başlamama vesile olan, Belçika'daki tez danışmanım Prof. Dr. Ruben Vanderlinde! Sevgili "critical friend", iyi ki varsın ve iyi ki seninle birlikte çalışma şansını haiz oldum. Son olarak doktoram süresince Belçika'da ve Türkiye'de her daim yanımda olan, tez yazma sürecinin bütün zorluklarını sabrına ve sevgisine sığınarak aşabildiğim, biricik kızımın dünyalar güzeli annesi İlknur Bilgin Banoğlu'na en içten sevgilerimi sunuyorum. Sosyal bilimlerin ve bu tez çalışması dâhil sosyal bilimler alanında yürütülen tüm bilimsel çalışmaların bir ferdi olduğumuz büyük insanlık ailesinin ortak mutluluğuna katkı sağlayacağına dair ümidim; daha eşit ve adil bir dünyayı bilimsel düşüncenin ışığında birlikte kuracağımıza olan sarsılmaz inancımla okuyuculara saygılarımı sunarım.

İstanbul, Aralık 2019

Köksal Banoğlu

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CHAPTER 1

GENERAL INTRODUCTION

Abstract

Chapter 1 presents a general introduction to the four main empirical chapters reported in this dissertation. The general aim of this dissertation is to get an advanced insight into multivariate factors that influence ICT integration attempts in Turkish public K-12 schools on an empirical basis. To do this, we capture ICT integration through the theoretical lens of technology leadership, learning organisation culture, and professional learning literature. To outline the theoretical underpinnings of the dissertation, we present a contextual and conceptual introduction at the outset by which this doctoral research was undertaken. In addressing the Turkish context with regard to ICT integration into K-12 schools, this section begins with a review of past and recent track records of ICT integration attempts into public K-12 schools in Turkey. This section is followed by a conceptual framework which gives a brief explanation of technology leadership (TL), learning organisation (LO) culture, ICT self-efficacy, and professional interactions. Next, the four research objectives corresponding to each empirical research are presented. These research objectives are: a) to examine the predictive ability of LO culture to principals' TL practices, b) to examine the predictive ability of principals' TL practices to teachers' perception of LO culture, c) to develop a research instrument that measures professional self-efficacy levels of ICT coordinators, and d) to delineate teachers' professional interactions through their technological and pedagogical advice-seeking relationships (ASRs). All research objectives are challenged with quantitative research approaches using latent class analysis, logistic regression analysis, social network analysis (SNA), and scale development procedures. Finally, the general overview of the dissertation is described and illustrated by an overall figure.

INTRODUCTION

The integration of information and communication technologies (ICT) in education refers to the effective use of ICT as tools to accomplish specific pedagogical activities in the classroom environment, and to meet certain instructional objectives of the school system (Lim, 2007). The immediate objective of ICT integration implementations is to ensure widespread access to ICT infrastructure by which teachers can enrich their repertoire of teaching practices and students can develop new learning strategies (Downes et al., 2002). The extent to which teachers have access to ICT and how frequently they integrate it into their pedagogical activities are two measurable achievement indicators of the immediate objective at the global level (European Commission Final Report, 2013; OECD, 2001, 2015).

Although statistics on the availability and range of ICT use in schools may provide baseline information about the achievement of this immediate objective, the innovative aspect of ICT integration further lies in its transformative impact on cultural norms and social relations (Law, Yuen & Fox, 2011). The implications of that transformation for schools are especially evident from the improvement in their capacity for pedagogical innovations and drastic shifts in the learning processes of teachers as well as students towards more collaborative and cooperative learning orientations (Mioduser et al., 2003). Undoubtedly, a school's ICT infrastructure in itself has nothing to do with teachers' digital competences by which they could adopt ICT tools for innovative pedagogies (Petterson, 2017). Still yet, individual teacher beliefs, attitudes, various sets of skills and digital competences in themselves cannot explain how a school's organisational structure and sociocultural context came to be transformed by ICT integration implementations (Lim, 2007). Thus, introducing ICT as an integral component of a schoolwide reform can constitute the ultimate objective of ICT integration that transforms the school's organisational structure and sociocultural context (Downes et al., 2002). For doing so, the transformative potential of ICT integration carves out its own niche by creating systemic changes in teacher roles (Zhao & Frank, 2003), leadership practices (Dexter, 2011), innovativeness capacity (Law, Yuen & Fox, 2011), social relationships, and teacher commitment to school culture (Frank, Zhao & Borman, 2004).

Despite this broad area of inquiry, ICT integration research can be classified into two major streams that originate from their two different foci (Venkatesh et al., 2003); which are 1) individual teacher reactions to ICT adoption, and 2) conditions and constraints of ICT integration implementations at the organisational level. A recent and comprehensive literature review showed that empirical research in the first stream has extensive coverage in education literature (Marangunic & Granic, 2015). However,

to the best of our knowledge, the second research stream has drawn relatively less attention from researchers to handle ICT integration at organisational level, regarding pedagogical innovation and sociocultural transformation as integrated aspects of organisational change (see. Lim, 2002; Tearle, 2004; Tondeur, Valcke & van Braak, 2008; Vanderlinde & van Braak, 2010). The above mentioned four studies deserve special attention for two reasons. First, they are distinguished by modelling ICT integration implementations within a multilevel (nested) context (e.g. teachers nested in schools). Another notable feature that makes these models different from others is their concentric framework structure that is represented as a series of concentric layers centred around a core containing the dependent variable(s). Such a concentric framework structure without overlaps assumes that there exists a nested hierarchy, N.B. but not necessarily an interaction, among its layers: e.g. classroom, school, education, societal systems (Lim, 2002); cultural/structural teacher and cultural/contextual school characteristics (Tondeur et al. 2008); individual, structural, sociocultural factors (Tearle, 2004); actual ICT using ways, ICT-related teacher conditions, ICT-related school conditions, and school improvement conditions (Vanderlinde & Van Braak, 2010). In the following section, first, we give a brief overview of the selected four ICT integration models. Next, the hierarchical framework structure of the models is challenged to interrogate multiple relationships within the same layered factors.

ICT Integration Models

Using the sociocultural lens of the cultural and historical activity theory, Lim (2002) adapted a theoretical model of ICT integration implementations in schools. The underlying assumption lying behind his model is that ICT integration cannot exist in isolation from ICT users' context-dependent and object-oriented mental/practical routines, values and social relations. The activity system model of ICT integration regards the education system and society as the most inclusive sociocultural context, which is hence depicted in the outermost concentric layers. Lim (2002) asserted that the systemic change movements coming from the outermost layers (e.g. ICT integration agenda) are likely to have far-reaching consequences in the more inner layers/subsystems, i.e. school and course subsystems. The most sophisticated part of the activity system model lies in the core (i.e. instructional use of ICT), which is rendered as a recursive function of six inter-linked components (i.e. subject, tools, object, rules, community, division of labour). Lim (2002) put a particular emphasis on the tool component because he suggests that school actors' cognitive and sociocultural settings are mediated by the use of ICT tools outside the bounds of classrooms, schools, and even the education system. Thus, ICT-mediated

considerations can operate within all four concentric layers: the course of lesson, school system, education system and society at large. Regulation of these reflections throughout the school system concerns the “rules and community” component, i.e. school ICT culture. To clarify the function of this component, Lim (2002) identified school ICT culture with its three indicators: 1) leadership support, 2) exchange of ideas between teachers, and 3) staff involvement in ICT integration implementations. A full discussion of the six components lies beyond the scope of this dissertation; notwithstanding that, out of these components, the strong leadership and exchange of ideas between teachers will be further elaborated in relation to school culture in the theoretical framework section.

Second, Tearle’s (2004) case study of a UK secondary school brought out a holistic model framework, called “the whole school approach”. This model also underlined the overarching role of sociocultural context in shaping a schoolwide change orientation with strong leadership, teachers’ collective and individual attitudes, values, beliefs about ICT integration. It was illustrated by four concentric layers: 1) socio-cultural factors, 2) structural factors, 3) individual teacher characteristics. In the innermost layer, individual teacher characteristics were represented by teachers’ 1) positive attitudes and beliefs about ICT, 2) ICT-related knowledge and skills. In the second inner layer, structural factors were given as 1) the provision of adequate ICT resources, 2) a well-planned internal ICT policy, 3) well-qualified support staff, and 4) professional development activities. In the outermost layer, socio-cultural factors were regarded as 1) strong leadership, 2) positive school culture, 3) collective motivation for organisational change, 4) openness to external influences, 5) well-established internal communication factors.

Based on quantitative research data collected from 527 teachers in 68 Flemish primary schools, Tondeur and his colleagues (2008) developed another holistic model of ICT integration that was also composed of four concentric layers. However, unlike the previous models, Tondeur and his colleagues (2008) set three dependent variables into his model’s core, such as 1) ICT use as a basic computer skill, 2) ICT use as an information tool, and 3) ICT use as a learning tool. In the innermost layer, three cultural teacher characteristics were interpreted as the individual factors of ICT integration: 1) teacher’s traditional vs. constructivist teaching beliefs, 2) computer attitudes, and 3) innovativeness. In the second inner layer, two structural teacher characteristics took place as non-changeable individual features: 1) teacher’s actual ICT experience, and 2) gender. In the most peripheral zone, school characteristics were divided into two layers including cultural and structural school characteristics. In this way, the third innermost layer included five cultural school characteristics: 1) supportive leadership, 2) school’s

openness to change, 3) school's goal orientedness, 4) ICT school policy, and 5) internal ICT support. In the outermost layer, two contextual school characteristics were involved, such as 1) the availability of ICT infrastructure, and 2) student/computer ratio.

Drawing on empirical evidence from previous models and quantitative research data collected from 471 teachers in 62 Flemish primary schools, Vanderlinde and van Braak (2010) developed the "e-capacity" model of ICT integration. They deployed the term "e-capacity" as the ability of a school to ensure a holistic ICT transformation throughout the school. This model was also illustrated by four concentric layers though, the factors included in the e-capacity model were differently layered than the previous models, such as 1) teacher's actual ICT use, 2) ICT-related teacher conditions, 3) ICT-related school conditions, and 4) school improvement conditions. In the centre of the e-capacity model, there placed a twofold core consisting of two dependent variables (i.e. ICT curriculum implementation and using ICT as a lever for instructional change). In the innermost layer, three ways of teachers' actual ICT use took place: 1) basic ICT skills, 2) an information tool, and 3) a learning tool. In the second inner layer, ICT-related teacher conditions were added into the model: 1) ICT teacher's professional development, and 2) teachers' ICT competencies. Following that, ICT-related school conditions were involved in the third inner layer, such as 1) the availability of ICT infrastructure, 2) ICT policy planning, 3) shared ICT vision, 4) technical and pedagogical ICT support, 5) the role of ICT coordinator. In the most peripheral layer, school improvement conditions were given as 1) teacher participation in decision making, 2) strength of professional relationships among teachers, and 3) effective leadership practices take place.

Taken together, we draw two major conclusions from the four models presented above. First, there seem to be sociocultural and structural factors of ICT integration that all models have in common: those are 1) supportive leadership practices, 2) a positive school culture promoting teacher development, 3) professional interactions among school actors, 4) availability of ICT infrastructure, and 5) qualification of ICT support staff. Based on this interference, the present Ph.D. dissertation handles ICT integration in education with a particular focus on these five factors. The second conclusion that can be commonly drawn from the models is that the achievement of ICT integration remains at risk of being limited by individual success stories, if not accompanied by systemic changes in the capacity of these five factors. Thus, the present research examines individual and school-level measures in multilevel research design.

Relationships between Sociocultural Factors

Although a great variety of factors associated with ICT integration were addressed in the literature, some concerns about the unexplored relationships among those factors seem to have remained valid over time (Zhao & Frank, 2003, p. 5):

"In sum, previous research has resulted in a long, almost exhaustive, list of factors that may affect the uses of technology in schools. However, these factors are often examined in isolation from each other or from the system in which they interact."

Subject to this criticism, for instance, the model proposed by Tondeur and his colleagues (2008) assumed that there exists a cascade of effects among the layered factors. Hence, the factors from outer layers were explained by means of the factors from inner layers. Vanderlinde and van Braak (2010) acknowledged the logical connection of factors grouped in the same layer. However, they also regressed the layered factors step-by-step on the dependent variable in a hierarchical order. Tearle (2004) remarked that the factors included in her model were interlinked in a complex way. Nevertheless, *"no attempt has been made in the diagram to show how the various factors interact, or may be influenced by others, the detail of which was not addressed in this particular study"* (p.344).

In addition to methodological constraints, what makes this issue even more complex on the theoretical basis is the potential mesh-up between pre-requisites and ends of organisational change in general (Schein, 1990, 1993). To put it differently, some factors related to organisational change may come into play both as a result and a cause of the change. With a reflection on ICT integration implementations, emerging changes in the school culture, social relationships, leadership practices or teacher roles can be both conditions and outcomes of ICT integration (Yancy, 2013). Note that, for this reason, we prefer to employ the umbrella term "factors" throughout the dissertation rather than the term "conditions" that implies prerequisites in particular.

To fulfill this critical research gap in the literature, the line of reasoning underpinning this study resorts to the ecological perspective that captures ICT integration through the relationships between the factors (Zhao & Frank, 2003). This perspective means a sociological approach that views how teacher actions were socioculturally mediated by forces that emanate from outside the classroom and even the school, instead, in the larger physical and social milieu (Bronfenbrenner, 1979). When applied to the issue of ICT integration in schools, the main premise underlying this perspective is that researchers need to shift their focus away from the influential factors in themselves to the relationship between those factors

which may be indirectly associated with ICT use (Zhao & Frank, 2003). It assumes that schools act like open and dynamic ecosystems that endeavour to keep an equilibrium between external innovations (e.g. ICT integration) and the internal sociocultural context. Sociocultural context tends to change in response to such innovation attempts. When ICT integration is introduced into a school system, teachers are compelled by bureaucratic, political, professional and commercial entities to orientate themselves with new working and thinking ways which are mediated by ICT tools (Davis, 2008). While doing so, they confront the pressure not only as individual teachers but also as members of a school system in which they operate. Depending on the school's normative social influence, teachers may exert social pressure on each other and provide contextualized information about the value of ICT use (Zhao & Frank, 2003). Besides, what is another sociocultural factor mediating ICT use in schools is a teacher's relational access to technical expertise through direct or indirect professional interactions (Frank et al, 2004). To conclude, the ecological perspective mainly assumes that most factors do not directly influence ICT use in a linear fashion; instead, their influence is filtered and mediated by a teacher's perception of sociocultural context and social relations (Frank, 2009).

In light of the ecological perspective, this study aims to explore multiple relationships among ICT integration's three sociocultural factors (i.e. supportive leadership practices, a positive school culture that promotes teacher development, professional interactions between teachers). While doing so, we statically control for one structural factor (i.e. school's ICT infrastructure) and some individual teacher characteristics (i.e. age, gender, teaching experience by years, administrative position, taught subject-field or grade). In addition, we develop a research instrument that measures ICT coordinators' self-efficacy levels as a proxy of the second structural factor (i.e. the qualification of internal ICT support).

The overall structure of the present Ph.D. dissertation is composed of six chapters. Besides the first introductory chapter and the last discussion chapter, the remaining four chapters report four empirical studies. In the following section, we present the Turkish research context in which we conducted four empirical studies. Next, we articulate the theoretical framework from which our research objectives are drawn. In the end, we explain research design and methodology employed in the four empirical studies.

RESEARCH CONTEXT

The two structural factors (i.e. quality of internal ICT support and availability of ICT infrastructure) are highly contextualised in Turkey by the assignment of ICT coordinators and the sizable ICT investment in Turkish public schools initiated by Turkey's first national ICT integration project: the Fatih project. In

the following two sections, attention is therefore paid to ICT coordinators and ICT integration implementations in the context of the Fatih project.

ICT Coordinators in Turkey

The research context of the present dissertation is situated in the Turkish education system. The national education system in Turkey has always been highly centralized under the supervision and control of the Turkish Ministry of National Education (TMONE) (Papadopoulo & Yirci, 2013). When it came to ICT integration agenda, yet, this centralization tendency in TMONE has turned towards a process of "fragmented centralization" (Tolu, 2014). Such that highly centralised control of decisions continued to prevail; whereas, the accountability of these decisions weighed on the shoulders of individual ICT users especially with the emergence of ICT coordinators in schools (Monahan, 2005). Hence, ICT coordinators have been expected to perform a wide range of tasks, such as teaching ICT skills, coordinating the development of ICT curriculum, maintenance of ICT infrastructure, providing technical support and training to teachers (Araiz, 2018).

To identify a legal ground for ICT coordinators, TMONE (2012) issued a regulation on the tasks which they are supposed to carry out. As per this regulation, ICT lessons can be taught by ICT coordinators in Turkish primary and middle schools. Apart from ICT teaching activities, ICT coordinators are also considered responsible for maintaining ICT tools and providing technical support to other teachers in all Turkish K-12 schools. In doing so, the competencies required for ICT coordinators had already been framed with the name of "National Competency Framework for ICT Coordinators" (TMONE, 2008). In this framework, ICT coordinators' 53 performance indicators were categorised into seven competence fields: 1) mastery of instructional design, 2) using ICT-related concepts properly, 3) measurement and evaluation tools, 4) hardware and software equipment, 5) multimedia applications, 6) instructional software, and 7) safe and ethical ICT use fields. To conclude, Turkish ICT coordinators are not only responsible for providing students with ICT-related skills as ICT teachers; but also, they take over some additional responsibilities, like the maintenance of the school ICT infrastructure and planning of ICT related professional development activities for other teachers.

ICT Integration Projects in Turkey

The integration of ICT in education is an international agenda all over the world, extending from Asian and American countries (OECD, 2015; UNESCO, 2014) to Europe (European Commission Final Report, 2013). However, national education authorities are far from agreeing on a common policy for ICT

integration (Pelgrum, 2001). Günay's (2014) review of 32 European countries showed how greatly ICT policies differ from country to country, even across Western and Eastern European landscapes. This review found that ICT lessons are compulsory in 15 European countries at either primary or middle school levels; whereas, the remaining 17 countries' ICT policies have not covered this lesson in the core curriculum. The European Commission reported that not only educational ICT policies but also staffing policies vary across European countries (European Commission Final Report, 2013). In some countries, like Lithuanian, ICT coordinators have never been officially introduced into schools (Markauskaite, 2003). Dexter (2011) reported that, on average, only 31% of U.S. public schools have a full-time ICT coordinator. At the other end of the spectrum, the national ICT policy of France stipulated that all lower and upper secondary schools should have at least one ICT coordinator (Regnier, 2003). As for Turkey, 60% of Turkish primary school students, 70% of Turkish middle school students, and 50% of Turkish secondary school students were receiving education in a school with an ICT coordinator (European Commission Final Report, 2013). The lowest ratio of computer and interactive whiteboards to students had been reported in Turkey across all European Union and even candidate countries (European Commission Final Report, 2013).

To leap forward and provide Turkish public schools with ICT-enriched learning environments, Turkey's most expensive investment in the integration of ICT into K-12 schools was launched in 2012, namely "Movement to Increase Opportunities and Technology" project (Tr. Fırsatları Artırma ve Teknolojiyi İyileştirme Hareketi [F@TİH] project). TMONE (2013) declared that 42.000 schools and 570.000 classrooms would have been supplied with up-to-date interactive smart boards and tablet computers until the end of 2015. The allocated budget for this project was nearly $1.8 billion (Uluyol, 2013). In order to underscore the importance of the project, the former prime minister - and now the president of the Turkish Republic- Mr. Recep Tayyip Erdoğan made an introductory speech broadcast on televisions, as partly cited below ("New information age with F@TİH", 2012):

> *"Ottoman Sultan, Fatih Sultan Mehmet, had closed the middle age and opened a new period all over the world. Now, thanks to F@TİH Project, we will close the dark age of not solely the education system but also the periphery of the education system. Therefore, we initiate a new information and technologies age altogether."*

Despite of this political discourse and following intensive media coverage, empirical research showed that the implementation of Fatih project had been impeded by unstable government

policies (Çiftçi, Taşkaya & Alemdar, 2013; Pamuk et al., 2013), ill-planned professional development activities (Banoğlu et al., 2014), lack of technical support (Koçak & Gülcü, 2013), and infrastructural shortcomings (Özkan & Deniz, 2014). In addition to these policy-related problems, an array of school-based localised problems seem to impede the success of the Fatih project. Those can be listed as occupational burnout (Seferoğlu, Yıldız & Yücel, 2014), role conflicts between ICT coordinators and other teachers (Yeşiltepe & Erdogan, 2013), and the perceived role ambiguity of ICT coordinators in the school environment (Dursun, 2015).

As presented above, a substantial body of empirical research has examined a wide range of problems confronted in the implementation of the Fatih project. Yet, the empirical research on conditions or outcomes of the Fatih project has remained rather scant (Durak & Sarıtepeci, 2017; Geçer & Taşdemir, 2017a, 2017b). To our knowledge, no empirical research has explored the sociocultural transformation of schools in the context of the Fatih project. In the next section, we provide a theoretical framework to better understand which sociocultural factors could be specified in this context.

THEORETICAL FRAMEWORK

To fully appreciate the critical role that sociocultural factors play in the integration of ICT into schools, it is necessary to examine their relationships with one another (Zhao & Frank, 2003). However, the three sociocultural factors (i.e. supportive leadership, positive school culture promoting teacher development, professional interactions among school actors) on which we based this study are too generic for such an examination. In narrowing them down to more specific fields of study, we take TL practices as a proxy for supportive leadership (ISTE, 2009); the learning organisation (LO) culture for a positive school culture that promotes teacher development (Divaharan & Lim, 2010; Dexter, 2008); and advice-seeking relationships for professional interactions among school actors (Siciliano,2016).

Technology Leadership

TL is a core ingredient for successful ICT integration into K-12 schools (Anderson & Dexter, 2005). TL can be defined as "*organisational decisions, policies or actions that facilitate effective utilisation of technology throughout the school*" (Anderson & Dexter, 2005, p.60). The term TL hinges on a combination of various school leadership practices with a particular focus on the use of ICT for improving learning and teaching activities in schools (Flanagan & Jacobsen, 2003; Tan, 2010). To better explain what TL practices are expected from school principals, various educational organisations and

associations strived to construct distinct and clear international standards (e.g. ISTE-A, 2002, 2009). Below are the five TL standards suggested by the leading association of the International Society for Technology in Education (ISTE-A, 2009):

1. *Visionary leadership*: School principals should inspire and lead an acceptable, cohesive and integrated technology vision shared by all stake-holders in the schools. Visionary leadership facilitates technology diffusion into school atmosphere by means of teachers' effective and technology oriented instructional activities, the presence of a school technology plan aligned with other management plans, and well-structured budget management practices.
2. *Digital-age learning culture*: School principals should support a school-wide cultural transformation in a way that diffuses effective ICT use practices into teacher communities. Digital-age learning culture nominates school principals as model persons in the use of ICT, and as such, they should pay a particular focus to learner-centred needs of individual teachers and students.
3. *Excellence in professional practice*: School principals should promote and empower professional learning activities so that teachers can gain positive beliefs, attitudes and skills about the value of ICT use in instructional practices. Allocation of enough time and financial resources for teachers' professional learning is the keystone to stimulate educators to technology use. Besides, this standard compels principals to follow contemporary research studies on technology-enriched instructional activities.
4. *Systematic improvement*: School principals should ensure both organisational and individual learning culture in schools. Since TL practice does not merely stimulate individual ICT-oriented teacher behaviours in instructional activities, they are also to constitute a strong base for the development of a collective sense of ICT-orientation in teachers' professional learning orientations both inside and outside school. To this end, school principals should define concrete achievement goals about ICT use and set clear measures to follow up. This standard draws on the importance of staff recruitment procedures in order to team up with ICT-competent teachers. Moreover, this standard suggests school principals to establish and leverage strategic partnerships with other organisations in order to support systemic improvement throughout the school.

5. *Digital citizenship*: School principals should be ethical models with their social, ethical and legal use of ICT. Besides, school principals make sure equal rights for all teachers and students to access to ICT tools. Not only do they set the boundaries of ethical ICT use but also promote those behaviours by clearly defined educational policies.

Taken together, ISTE-A (2009) standards provide concrete indicators for assessing school principal's effective TL practices (Richardson & McLeod, 2011; Yu & Prince, 2016). They also imply that TL is not a leadership style derived from a new leadership theory, but rather, a new direction for effective leadership practices (Gurr, 2004). It inspires a multifaceted cultural process that stimulates pedagogical innovations and the rise of a collective learning orientation within teacher communities (Dexter, 1999). As this builds the collective sense of working and learning in schools, TL practices have an influence on the actions of those who follow leaders, which in turn shape the school culture in which school leaders can act (Dexter, 2011).

In chapter 2, we investigate the likely influence of TL practices on the promotion of a positive school culture in which teachers appreciate professional development to a larger extent. For this investigation, first, we classify school principals into profiles based on their self-report TL practices measured on the ISTE-A (2009) standards. Next, we regress the indicators of a positive school culture, i.e. LO culture (Dexter, 2008), on the profiled TL practices. In the following section, we elaborate on the concept of LO culture that we employed to identify a positive school culture promoting teacher development in schools.

Learning Organisation Culture

Before giving the definition of LO culture, we need to distinguish the concept of organisational culture at the outset because these concepts are often used interchangeably in the management literature; nevertheless, there is subtle difference in their usage. Organisational learning can be defined as an array of learning processes that support the acquisition, retainment and transferring of knowledge within an organisation (Argryis & Schön, 1974). Whereas, LO culture refers to an organisational culture based on shared values, beliefs and norms that exist in an organisation to improve individual and collective learning capacity for adapting and changing continuously (Watkins & Marsick, 1993). While the use of organisational learning concept traces back to 1930s in the management literature (Dutton, Thomas, & Buttler, 1984), LO culture has received growing attention since the seminal work of Senge (1990). A decade later, the concept began to gain much attention in educational research since the *"School that Learn: A Fifth Discipline for Educators, Parents and Everyone"* came out (Senge et al., 2000). In the

present dissertation, we use the theoretical lens of Senge (1990) to underpin a positive school culture that supports teachers' professional development.

Fullan (1995) indicates that LO culture requires developing a collaborative work culture that goes hand in hand with major structural changes in school settings. In doing so, LO culture seeks to create a purposeful community in pursuit of the five professional learning orientations (Senge, 1990). Senge conceptualized these orientations as personal mastery, shared vision, mental models, team learning and systems thinking.

1. *Personal mastery*: This orientation concerns "*continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality objectively*" (Senge, 1990, p.7). To put it differently, personal mastery is about the personal commitment and capability of an organisational member to grow professional skills in line with her personal vision (Garcia-Morales et al., 2007). As such, vital to personal mastery is the attainment of self-motivation (Ng, 2004). For those with a high level of personal mastery, they constantly face a kind of structural tension between making better choices and actualisation of present choices for desired results (Fritz, 1989). This tension results from the antagonism between current reality and personal vision (Flood, 1999). While the former compels organisational members to get a better awareness of current conditions, the latter lays clear stress on organisational vision. As a result, personal mastery orientation draws on the integrity of individual and collective aspiration that can be set free by the effective leadership interventions (Retna, 2011).
2. *Shared vision*: *"A vital (need) for the learning organisation because it provides the focus and energy for learning"* (Senge, 1990, p.206). This professional learning orientation brings people together around a common future aspiration (Appelbaum & Goransson, 1997). Communication channels play a mediator role in linking different communities (e.g. teachers, students, parents for educational settings) in order to nourish organisational commitment to common purposes. In the broadest sense, shared vision serves for bringing all distinctive personal goals and visions into alignment (Senge, 1990).
3. *Mental models*: This orientation is composed of ideas and beliefs internalized by organisational members to explain the cause and effect relationship in their minds for guiding their actions (O'Connor &McDermott, 1997). In other words, these are "*deeply ingrained assumptions, generalisations, or even pictures or images that influence how we understand the world and*

how we take actions" (Senge, 1990, p.8). Seeing that our personal images, assumptions and perceptions constitute a baseline motivation for our reaction to a given reality, it is then a logical deduction that mental patterns are able to shape our reality perception that goes beyond the genuine reality. Besides, effective communication plays a key role in sharing new mental models within a group of people (Jamali, Khoury & Sahyoun, 2006).

4. *Team learning*: This orientation accounts for "the process of aligning and developing the capacity of a team to create the results its members truly desire" (Senge, 1990, p.236). It constitutes a linkage between individual and organisational learning in that knowledge is first created by individuals, after that through the process of team learning, it can be converted to organisational knowledge (Watkins & Marsick, 1993). By this means, it establishes a creative working and learning routine such that team members manifest a collective capacity greater than the sum of gains that individual members can accomplish alone (Hitt, 1995).
5. *Systems thinking*: This refers to an overarching orientation that encourages people to capture organisational problems in the full setting of the interconnecting structural elements of embedded systems (Hosley et al., 1994). It fundamentally assumes that the nature of problems is based on relationships rather than problematic entities isolated from each other (Senge, 1990). Evaluation of feedbacks constitutes the backbone of the systems thinking orientation because all systems give reaction to the change pressure (e.g. ICT integration agenda) but only robust systems make adjustments with this feedbacks that allow them to operate in a stable and reliable manner (Maddin, 2014).

Drawing on the importance of LO culture in schools, Dexter (2008) concluded that TL practices should inspire the team learning, build the shared vision and employ the systems thinking orientation among teachers. Anderson and Dexter (2005) called LO culture necessary to refine a proper school culture supporting the success of ICT integration. LO culture was considered important to motivate teachers to adopt ICT tools in their pedagogical activities (Divaharan & Lim, 2010). It was also found to be useful to foster a strong commitment to school's technology vision (Yuen, Law & Wong, 2003). In light of these theoretical and empirical underpinnings, in chapter 3 we cluster teachers into distinct profiles in order to disclose distinct LO profiles through the perceived school culture. Next, we investigate the predictive ability of TL practices on the emerging LO profiles.

ICT Coordinator's Self-efficacy

The critical role of ICT coordinators in the integration of ICT in schools has begun to be studied at the end of the 20th century (Strudler, 1995). Since then, many studies were undertaken to explore the extent to which ICT coordinators may have an impact on ICT integration (Banoğlu, 2011; Fraizer & Bayley, 2004; Lai & Pratt, 2004; Hayes, 2007). Today, it is widely recognised that they play a pivotal role in the implementation of ICT integration as they contribute to ICT planning processes (Vanderlinde, Dexter, & van Braak, 2012), maintenance and upkeep of educational technologies (McGarr & McDonagh, 2013), the preparation of digital contents (Rodriguez, Pozulelos & Leon, 2014), and the development of professional relationships with other teachers in regard to the integration of ICT into teaching activities (Skues & Cunningham, 2013).

Despite recent heavy workload on ICT coordinators, only few studies (e.g. Deryakulu et al., 2008; Ekici, Ekici & Kara, 2012) have specifically dealt with ICT coordinator's self-efficacy which indicates the extent to which they feel themselves efficient while doing their tasks in the school system. According to Bandura (1997), self-efficacy refers to individual judgements about one's own capabilities to organise herself to get into action in alignment with desired goals. More specifically for teachers, self-efficacy explains teacher's professional self-perception to change student knowledge, values and behaviours (Friedman & Kass, 2002). As for the ICT coordinator's actions, ICT self-efficacy accounts for personal judgement of one's own ICT competence to bring about a desired educational change (Karsten & Roth, 1998).

Although ICT coordinator's job definition varies from country to country (Law & Plomp, 2003), there is a wide consensus that they play a pivotal role in building the professional development capacity of school systems if they are personally equipped with strong ICT competencies (Araiz, 2018; McGarr & McDonagh, 2013; Tearle, 2003). When the ICT competencies complement interpersonal communication skills, then other teachers come to benefit from ICT coordinators' pedagogical and technological expertise even to a larger extent (Wong, 2008). According to Lesisko (2005), ICT coordinators are not only technological-pedagogical experts in ICT-supported learning activities. They also play a vital role in supporting school principals with their ICT expertise. Likewise, Banoğlu (2011) revealed that ICT coordinators make a significant contribution to TL practices executed by school principals. The more they feel themselves knowledgeable and enthusiastic about the use of ICT, the more they take on a leadership position to guide other school actors towards the targets of ICT integration (Lai & Prat, 2004).

To clearly identify what professional competencies are required for Turkish ICT coordinators, as mentioned before, TMONE (2008) embarked on developing a *"National Competency Framework for ICT Coordinators".* The performance indicators (e.g. setting ICT-related instructional goals, developing web-based materials, informing learners about the ethical dimension of ICT use) categorised by this framework distinguish ICT coordinators' pedagogical competencies from the technical ones. As such, the developed competency framework and its performance indicators are useful to form a research instrument with multiple items, which measures ICT coordinators' self-report beliefs about their professional self-efficacy. However, to the best of our knowledge, no scholarly attention has so far been paid to the development of such a research instrument based on this framework. To fulfill this gap, in chapter 4 we attempt to develop a research instrument with robust psychometric properties. We believe that this chapter further strengthens our comprehensive viewpoint that takes into account ICT coordinators' self-efficacy, school principals' TL practices as well as the school's LO culture in a particular context.

Professional Interactions

The forms of teacher collaboration range from story-telling activities through resource sharing and help-advice exchanges to joint work experiences (Little, 1990). Out of these collaboration forms, the professional interactions by which teachers engage in advice exchanges on technological-pedagogical issues are mostly interrelated (Ryymin, Palonen & Hakkarainen, 2008), susceptive to LO culture in schools (Siciliano, 2016), and operationalised through on-the-job advice seeking relationships because they trust each other much more than outside assistance coming from non-educators (Carr, Johnson & Bush, 2017; Parise & Spillane, 2010).

In a broad sense, teacher professional development refers to the improvement process of teachers' job-related knowledge, skills and attitudes (Guskey & Sparks, 1991). As part of a teacher's professional development trajectory, professional learning accounts for long-term and internal construction of teacher learning that is manifested through individual and collaborative professional interactions (De Neve, Devos & Tuytens, 2015). In this sense, advice-seeking relationships (ASRs) embody the most common type of teacher learning within teacher communities (Little, 1990). ASRs refer to a sort of informal enculturation process within socially organised and individually constructed learning environments (Borko, 2004). This perspective regards teachers as professional learners who participate in teaching

and learning practices inside classrooms as well as outside through engaging in professional interactions with colleagues (Putnam & Borko, 2000).

Growing evidence suggests that professional interactions is susceptible to the organisational environment where teachers share a vision to reflect on their teaching practices (Scribner et al., 2007). Penuel, Sun, Frank and Gallagher (2012) also draw upon the regulatory effect of workplace conditions on teachers' professional interactions by which collegial knowledge and expertise exchanges facilitate teachers' professional growth. Furthermore, Boyle, While & Boyle's (2005) longitudinal study shows that primary and secondary school teachers mostly predicate their long-term professional learning experiences on their observations of colleagues and sharing practice.

While making collegial observations and sharing knowledge and practices through ASRs, teachers are expected to opt for expert colleagues, such as technology-savvy teachers for ICT-related problems or senior teachers for pedagogical issues. Technology-savvy teachers refer to expert colleagues who are more preferred as informal leaders than others to be sought out for professional advice about educational technologies (Kelly, 2015). All the same, some teachers may have different or overlapping areas of expertise, i.e. hybrid expertise, so that they can incorporate technological and pedagogical expertise into their professional interactions (Ryymin et al., 2008). In chapter 5, we use a sociometric approach that allows focussing on the relational aspect of ASRs rather than individual metrics of advice provider/receiver teachers, while investigating technological and pedagogical ASRs among expert, hybrid expert and non-expert teachers. As such, we can examine technological and pedagogical ASRs alongside the interrelatedness of ASRs in different schools cultures in which teachers perceived the highest and lowest level LO culture.

RESEARCH DESIGN AND OVERVIEW OF THE DISSERTATION

Problem Statement

The general aim of this Ph.D. dissertation is to get an advanced insight into ICT integration attempts in Turkey. For doing so, we propose that school principals' TL practices may be related to the occurrence of LO culture in schools and, in turn, the level of LO culture perceived by teachers may facilitate school principals to execute TL practices in regard to ICT integration in schools. In addition, we develop a research instrument that is able to measure ICT coordinator's self-efficacy. At last, we investigate the professional interactions among school actors (i.e. school principals, vice-principals, ICT coordinators and subject-field teachers) in order to understand whether ASRs on technological and pedagogical

issues are interrelated and differentiated in the schools with the high and low level perceived LO culture. The above described general aim is further divided into four research objectives:

Research objective 1 (RO 1): To examine the predictive ability of LO culture to principals' TL practices.

Research objective 2 (RO 2): To examine the predictive ability of principals' TL practices to teachers' perception of LO culture.

Research objective 3 (RO 3): To develop a research instrument that measures professional self-efficacy levels of ICT coordinators.

Research objective 4 (RO 4): To delineate teachers' professional interactions through their pedagogical and technological ASRs.

Research Design

Each research objective is examined through different analytical procedures, such as latent class analysis and logistic regression analysis for RO 1 and RO 2, principal component and confirmatory factor analysis for RO 3, and social network analysis for RO 4. This analytical diversity requires us to build a comprehensive research design on an empirical basis. While doing so, the main challenge is to control for multiple interplays among individual, relational and school-based factors in a unique research model. To that end, this work explores ICT integration in views of multiple school actors and their diverse organisational behaviours, such as a) principals' TL practices, b) teachers' perception of LO culture, c) ICT coordinators' professional self-efficacy, and d) all school actors' (i.e. principals, vice-principals, ICT coordinators and subject-field teachers) professional interactions about technological and pedagogical issues. As such, the present dissertation is guided by the following four research objectives explained below and presented in Table 1.

RO 1 is tackled using a correlational research design in Study 1. The main goals of Study 1 were to profile school principals' TL practices, and thus to predict those resulting profiles by teachers' perception of LO culture. Data were collected using principal and teacher surveys by which participants were asked to provide demographic information about themselves, and to respond to the TL scale (administered to 58 principals) and LO scale (administered to 1105 teachers). For the first research goal, latent class analysis (LCA) was employed to delineate school principals' TL practices within distinct profile structures, whose indicators are composed of the five ISTE-A (2009) standards. Afterward, for the second research goal, we used logistic regression analysis at school level so as to determine the extent

to which resulting TL profiles (dependent variable) were predictable by teacher demographics and perception of LO culture (independent variables) that was manifested by the means of five professional learning orientations (Senge, 1990; Senge et al., 2000).

RO 2 is tackled using data that are drawn from the same research population as study 1. However, this time reversely taking dependent and independent variables into analysis, in a contrasting way with the order in RO 1, we capture 1105 teachers' perception of LO culture as distinct LO profiles (dependent variable) in order to determine the predictive ability of 58 school principals' demographics and TL practices (independent variables) to resulting profiles. Unlike study 1, multilevel latent class analysis (LCA) is used in study 2 because there occurred significant variance differences in teachers' perception of LO culture across schools. Later on, logistic regression analysis was carried out to determine the extent to which school principals' TL practices can predict the perceived means of LO culture among teachers in the same school (i.e. at teacher level) and variance differences of those across schools (i.e. at school level).

RO 3 attends to the development of a research instrument to measure the professional self-efficacy of ICT coordinators, using literature review and survey design approaches. In order to develop such a research instrument, we relied upon the "National Competency Framework for ICT Coordinators", which is constructed by TMONE (2008) under seven competence fields (i.e. competencies for instructional design, using ICT-related concepts properly, measurement and evaluation tools, hardware and software equipments, multimedia applications, instructional software, safe and ethical ICT use). Based on these competency fields, the developed measurement items were administered to 190 pre-service ICT coordinators. In addition to 190 ones, 67 pre-service ICT coordinators also participated in test-retest reliability study at two weeks intervals. For the construct validity of the developed research instrument, principal component analysis (PCA) and confirmatory factor analysis (CFA) were carried out.

RO 4 is tackled using sociometric inquiry of professional interactions among teachers through the state-of-art analytical approach of social network analysis (SNA). Instead of taking individual data as units of analysis, sociometric inquiry focuses on relational data constituted between two or more individuals in regard to one or more concerns. Data were collected from 336 teachers in 9 schools through an SNA survey. In this SNA survey, teachers were asked to respond to two questions about their technological and pedagogical advice-seeking relationships with other colleagues in the same school. Using exponential random graph models (ERGMs), collected sociometric data were analysed to disclose micro

(i.e. teacher gender, age, experience, departmental and/or administrative assignments), meso (interpersonal similarity of these features) and macro level (i.e. average teacher experience and teacher perception of LO culture) factors that may be influential to technological and pedagogical ASRs. Next, interaction patterns that are delineated from these disclosed ASRs were compared between two distinct school contexts where teachers perceived high-level or low-level LO culture in their schools.

Table 1. Research Objectives, Goals, Research Designs, Data Collection, Analysis Methods and Outputs

Research Objectives	Research Goals	Research Design and Data Collection	Analysis Methods	Outputs
RO-1: To examine the predictive ability of LO culture to principals' TL practices.	RG-1: To classify school principals according to their TL practice into distinct TL profiles. RG-2: To explore the predictive ability of teachers' perception of LO culture to school principals' TL profiles.	Correlational design - Principal survey (n= 58) - Teacher survey (n= 1105)	- Latent Class Analysis (LCA) - Logistic Regression	Chapter 2 (Study 1)
RO-2: To examine the predictive ability of principals' TL practices to teachers' perception of LO culture.	RG-1: To classify teachers according to their perception of LO culture into distinct LO profiles. RG-2: To explore the predictive ability of school principals TL practices to teachers' LO profiles at individual level and across schools.	Correlational design - Principal survey (n= 58) - Teacher survey (n= 1105)	- Multilevel Latent Class Analysis (MLCA) - Logistic Regression	Chapter 3 (Study 2)
RO-3: To develop a research instrument that measures professional self-efficacy levels of ICT coordinators.	RG-1: To identify professional self-efficacy indicators of ICT coordinators in accordance with the ICT Coordinator Competency Framework. RG-2: To construct and validate a professional-self efficacy scale for ICT coordinators	Literature review, Expert opinions Survey design - ICT coordinator survey (n= 190)	- Principal component analysis (PCA) - Confirmatory factor analysis (CFA)	Chapter 4 (Study 3)
RO-4: To delineate teachers' professional interactions through their pedagogical and technological advice-seeking relationships (ASRs).	RG-1: To disclose micro (i.e. teacher gender, age, experience, departmental and/or administrative assignments), meso (interpersonal similarity of these features) and macro level (i.e. average teacher experience and teacher perception of LO culture) factors that may be influential to teachers' pedagogical and technological ASRs. RG-2: To investigate the relatedness of pedagogical and technological ASRs,and whether to be differentiated in distinct school contexts where teachers perceive high-level or low-level LO culture	Sociometric design - SNA survey (n= 339)	- Social Network Analysis (SNA) - Exponential Random Graph Models (ERGMs)	Chapter 5 (Study 4)

Overview of the Dissertation

The present dissertation is structured in six chapters (see Figure 2). Apart from the introduction chapter at the beginning and the general conclusion chapter at the end, all other chapters of the dissertation have been either submitted or accepted for publication in peer-reviewed journals or as a book chapter. In the introduction chapter, a comprehensive overview of four research studies is drawn. At the outset, we clarify the concepts of TL practices, LO culture, ICT self-efficacy, and professional interaction. Moreover, the problem statement and research designs are presented.

In chapter 2, we investigate the predictive ability of teachers' perception of LO culture to principals TL practices. This chapter outlines the theoretical reasoning that underlies the empirical analysis of teachers' perception of LO culture, school's technological infrastructure (Fatih project schools versus other schools), some principal demographics (i.e. gender and age), and principals' computer and internet usage frequency. Next, we present the two-fold research design based on LCA and logistic regression analysis. Resulting TL profiles delineated through LCA of school principals' TL practices are plotted with dashed lines. In this first stage, we carry out clustering analysis to classify principals according to their TL practices into distinct sub-groups, i.e. profiles. The following logistic regression procedure that aims to predict resulting TL profiles by various independent variables is plotted by solid lines. In this second stage, we examine the predictivity ability of LO culture to TL profiles while taking some individual and structural variables under control. Chapter 2 was published in *Education Sciences: Theory and Practice,* which is an SSCI-index journal.

In chapter 3, we make use of the same data as chapter 2. However in the research design, unlike chapter 2, we replace dependent and independent variables in a way to examine the predictive ability of principals TL practices to teachers' LO profiles at individual and school levels. While doing so, we also control for some individual (i.e. gender, age, experience by years at current school) and structural factors (i.e. school stage and size). Note that, in chapter 2 and chapter 3, we purposefully undertake clustering analysis of dependent variables instead of the estimated means of those because clustering analysis provides us with distinct profile structures delineating interrelations among the sub-dimensions of dependent variables for every distinct sub-group. Chapter 3 was submitted to an international book project by Springer publisher.

Chapter 4 addresses a research instrument development study. Based on the ICT Coordinator Competency Framework, we construct a sample item pool to be reviewed by field experts, who are all

tenure track professors at Computer and Instructional Education Departments in 4 Turkish universities. Later on, we conduct statistical validity and reliability study of these items that measure the professional self-efficacy levels of 190 pre-service ICT coordinators. Chapter 4 was published in *Anthropologist,* which is an SSCI-index journal.

Chapter 5 is based upon a social network analysis (SNA) study. Exponential random graph models (ERGMs) are employed to investigate 339 teachers' technological and pedagogical advice-seeking relationships (ASRs) in 9 schools. Next, we investigate and compare how different interaction patterns of ASRs differentiate in the sub-sampled 6 schools where 82 teachers perceived the highest level of LO culture, on average, in 3 schools, and 104 teachers got the lowest score in 3 other schools. Chapter 5 was submitted to a SSCI-index journal of *Sociology of Education*.

Chapter 6 provides a general conclusion in order to synthesise the findings of previous chapters. While presenting an overview of the main results on the research questions, it also includes a data-driven discussion about ICT integration efforts into Turkish K-12 schools and concludes some practical implications for Turkish educational policymakers.

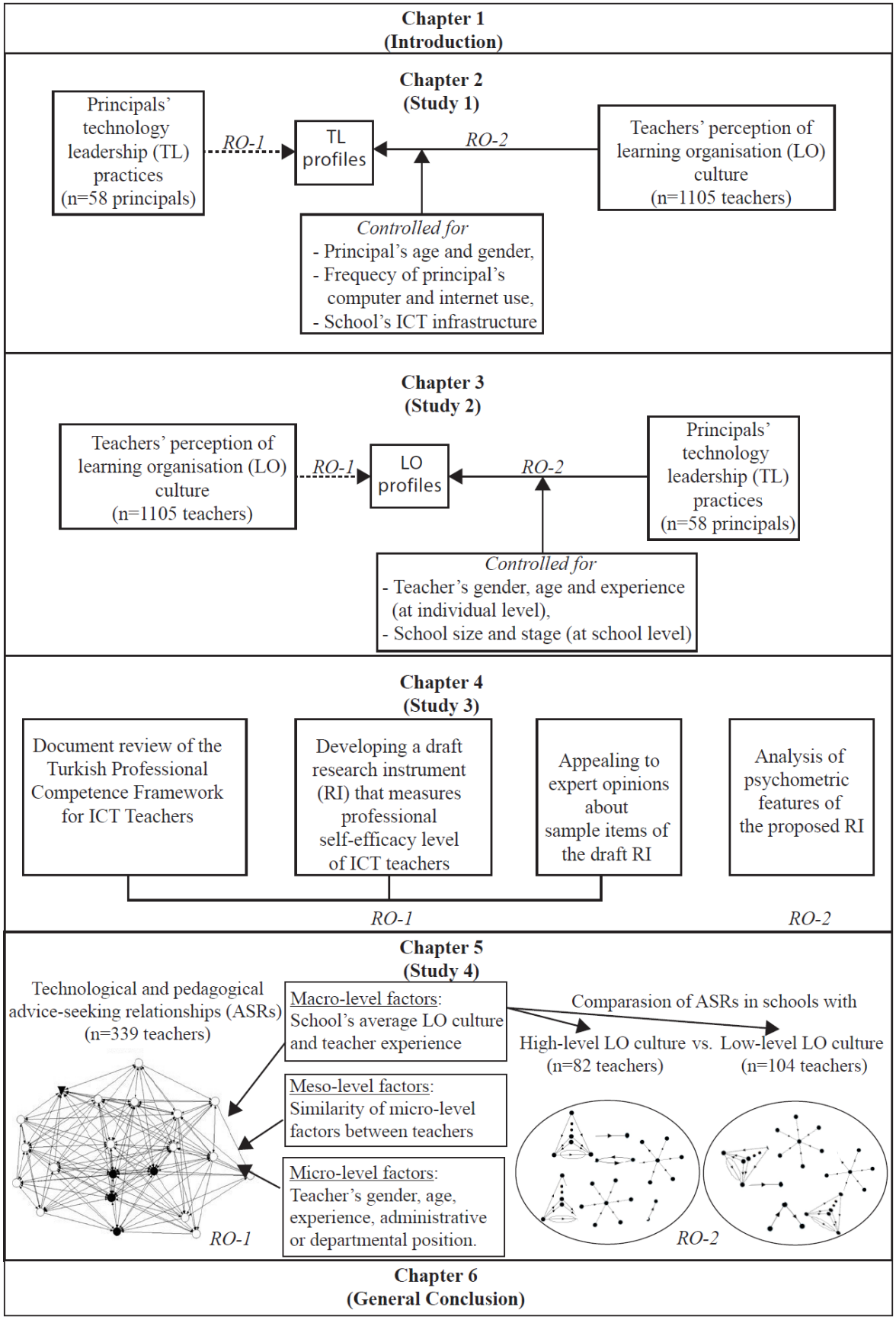

Figure 2: General Overview of the Dissertation

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CHAPTER 2

INVESTIGATION OF SCHOOL PRINCIPALS' TECHNOLOGY LEADERSHIP PRACTICES IN THE CONTEXT OF SCHOOLS' LEARNING ORGANIZATION CULTURE AND ICT INFRASTRUCTURE: FATİH PROJECT SCHOOLS VS. THE OTHERS

Abstract

Although there is a growing body of literature about the integration of information and communication technologies (ICT) into K-12 schools, little is known about the extent to which school principals' technology leadership (TL) practices are predictable by school culture as perceived by teachers and the availability of ICT infrastructure. In this exploratory study, first, we examine Turkish school principals' TL practices in order to classify them into distinct types of TL profiles. The extent to which school principals perform the five standards of International Society for Technology in Education (ISTE-A, 2009) is considered as the measure of their TL practices. Teachers' perception of team learning, shared vision and systems thinking profesional learning orientations is considered as a proxy for school's learning organisation (LO) culture. Principal's age and gender demographics, weekly computer and internet usage durations are statistialy controlled for. The current study surveyed 1105 teachers and 58 principals from 69 K-12 public schools located in an urban district of Istanbul city. Latent class analysis (LCA) was used to assign school principals to distinct TL profiles. Logistic regression analysis was undertaken to determine significant predictors of the outcome TL profiles. The results reveal that Turkish school principals can be classified into two profiles by their high and low levels of TL practices. Almost 55% of the principals were clustered in the high-level TL profile due to their strong interest to perform ISTE-A standards; whereas 45% were clustered in the low-level TL profile because of their relatively poor interest in the ISTE-A standards. The most striking result to emerge from this research is that Turkish principals are most likely to perform a higher level of TL practices as they a) run a Fatih project school with ICT-enriched classrooms; b) use internet technology for a longer period of time, c) manage a school in which teachers perceive a higher level of "team learning" professional learnin orientation.

INTRODUCTION

Turkish Ministry of National Education (TMONE) have been in a constant struggle for providing Turkish schools with modern information and communication technologies (ICT) since the early 80's (Tezci, 2011). Tracing back to the beginning of the new millennium, foreign-invested "World Bank - Basic Education I and II" projects can be marked as the most remarkable milestones in Turkey's ICT integration history, which granted 300 millions dollars worth of ICT equipments to Turkish schools (World Bank, 2002). Later, in 2010, Turkey's first national ICT integration project was introduced by TMONE with a great enthusiasm, namely "Movement to Increase Opportunities and Technology Project", also known as "Fatih Project" by its Turkish acronym ("Fatih Project", 2012). The total budget of this project reaches around 1.8 billion USD (Uluyol, 2013). The project was initiated in 4 selected schools as a pilot implementation in 2011, but soon its scope was extended to 17 provinces and 52 schools in 2012. According to project's master plan, nearly 620.000 classrooms should have been equipped with interactive smart boards, digital projectors and laptop until the end of 2015 ("Fatih Project", 2012). However, due to some unforeseen contractual problems in tender offers, only 10% of the project has been completed on the date promised and hence it was prolonged until 2019 (TMONE, 2015).

Given the enormous financial investement made to date, Fatih project has always been in the public eye and, maybe thus, also harshly criticized by some Turkish scholars for poor TL capacity (Gök & Yıldırım, 2015; Hoşgörür, 2013; Vatanartiran & Karadeniz, 2015), deficient human resource management (Günbayı & Yörük, 2014), underestimating the resistance of traditional school culture (Vatanartiran & Karedeniz, 2015), inadequate professional development facilities (Hoşgörür, 2013) and the lack of follow-up technical support (Akkoyunlu & Baskan, 2015; Banoğlu et al., 2014). In this respect, Vatanartiran and Karadeniz (2015) categorised a number of issues under three main themes, such as executive, infrastructural and instructional issues. In this paper, we bring a contextual focus on the executive (e.g. school culture) and infrastructural (e.g. school's ICT capacity) themes in order to scrutinize principals' TL practices.

Technology Leadership and Learning Organization Culture

The execution of TL practices is not subject to any fixed leadership position occupied by a sole school actor, but rather a school characteristic and change management processes embedded in the whole school context (Davies, 2010; Keller, 2005). Nonetheless, many studies support that school principals continue to play a key role in leading ICT integration processes in K-12 schools (Anderson & Dexter,

2005; McLeod, 2008; Yee, 2000). There is a large consensus on the fact that school principals' TL practices (Anderson & Dexter, 2005; Tan, 2010; Yuen, Law,& Wong, 2003), ICT using experience (Gurr, 2000; Schiller, 2003; Polizzi, 2011) and training level of technology (Dawson & Rakes, 2003; Polizzi, 2011) add to the success of ICT integration in K-12 schools. As the importance of school principals in influencing ICT integration became evident, the need arose for clear standards to define and measure school principals' TL practices (Richardson, Bathon, Flora,& Lewis, 2012).

For this purpose, the International Society for Technology in Education (ISTE) described five sets of TL practices, calling each a TL standard on what school principals should know and practice about educational technologies (International Society for Technology in Education for Administrators [ISTE-A], 2009; Richardson & McLeod, 2011). ISTE is a non-profit professional networking organization whose TL standards adopted or adapted by 80% of the states in USA (Kanematsu & Barry, 2016; Schrum, Galizio,& Ledesma, 2011). Richardson et al. (2012) reported that ISTE-A standards have gained remarkable international recognition outside USA, and specifically in Turkey. This scholarly interest in ISTE-A standards continues in Turkish educational research (e.g. Cakir, 2012; Güven, 2015; Hacıfazlıoğlu, Karadeniz,& Dalgıç, 2010, 2011; Sincar, 2013; Şahin & Demir, 2015).

ISTE-A (2009) standards are composed of visionary leadership, digital-age learning culture, excellence in professional practices, systemic improvement, and digital citizenship standards. Of these standards, "visionary leadership" standard describes school principal's TL practices to inspire a shared technology vision, ICT planning, and budgeting in schools. Developing a detailed technology plan consistent with objectives of the school and district level strategic plans is also detailed in this standard. The "digital-age learning culture" standard offers principals to be model of school community as ICT-oriented instructional leaders. The "excellence in professional development" standard focuses on ICT-related professional growth by providing teachers with the needed time and resource. The "systemic improvement" standard is related to school principal's networking acitivites with other organisations and data-driven decision making activities while recruiting ICT-skilled new staff, assessing and evaluating teacher-student performance based on digitalised data. The "digital citizenship" standard involves school principal's TL practices as to ethical, equal and fair ICT use in schools (Richardson & McLeod, 2011).

When the underpinnings of leadership practices are examined, three main factors come to the fore in the leadership literature: leader's personal traits, behaviors and school's organizational context

(Daugherty, Mentzer, Lybrook,& Little-Wiles, 2013). Traditionally, technology leaders have been profiled on their leadership traits and behaviors, such as tech-savvy and role-model principals with mastery of operational know-how knowledge about ICT use (Cooley & Reitz, 1997; Crouse, 1997; Roberts, 1997). Recently, however, such a "heroic" TL understanding has lost its popularity in the leadership literature. (Gurr, 2004; Tan, 2010). Instead, recent research have paid far more attention to contextual factors such as school culture and school improvement conditions (Tondeur, Devos, van Houtte, van Braak,& Valcke, 2009; Vanderlinde, van Braak,& Dexter, 2012). For instance, Flanagan and Jacobsen (2003) address five core features of TL practices: student engagement, shared technology vision, equal and fair access to ICT, teachers' professional development and ubiquitous infrastructural networks. Likewise, Dexter (2008) identifies three sets of TL practices in relation with social, cultural and infrastructural school contexts as follows: a) generating a shared technology vision in collaboration with teachers b) stimulating a professional learning environment among teachers and c) maintaining educational ICT equipments.

This shifting focus on the contextual variables inspired a great interest in the learning organization (LO) culture as well. Senge et al. (2000) coined the term LO culture through five profesional learning "orientations" whereby all educational stakeholders could express their aspirations and new ideas by "shared vision" and "team learning" culture; build awareness on schools' systemic stucture and their personal thinking ways by "mental models" and "systems thinking" culture; develop their professional capacity by "personal mastery" culture. Among these five orientations, Dexter (2008) drew on the pivotal role of three ones in improving TL practices, such as team learning, shared vision and system thinking cultures. Some other researchers considered the existence of LO understanding neccesary to refine a proper school culture supporting ICT integration process (Anderson & Dexter, 2005) and strengthen technology-oriented cultural change in schools (Flanagan & Jacobsen, 2003). Numerous empirical study found that LO culture encourages teachers to adopt ICT tools in their teaching activities (Divaharan & Lim, 2010), to promote fruitful collegial collaboration (Dexter, 2011) and to foster a strong commitment to school's technology vision (Yuen et al., 2003). Even it was laid down as a condition of an innovative school culture building technology-rich learning environment in schools (Law, Yuen,& Fox, 2011).

Purpose of the Study

Despite the abundant theoretical literature on the relationship between TL practices and LO culture, not much is empirically known about the extent to which a school principal's: a) gender and age b) computer

and internet usage duration in daily works, c) school's LO school culture, and d) school's ICT infrastructure can predict the TL practices performed by school principals. Therefore, there is a need to take into consideration all these individual, sociocultural and infrastructural variables in relation with TL practices. In order to fulfill such a research gap, the current study set out to profile principals' TL practices in relation with their individual demographics (i.e. age and gender), ICT usage (i.e. duration of computer and internet usage), school's LO culture (i.e. "team learning", "shared vision" and "systems thinkings" cultures; see. Dexter, 2008) and school's infrastructural conditions (i.e. involvement in the Faatih project). Without regarding each ISTE standard as a separate dependent variable, we consider important the overall characteristic of TL practices. To that end, we cluster school principals into sub-groups with similar TL practices, namely TL profiles (see. Samancıoğlu, Bağlıbel, Kalman,& Sincar, 2015). Next, we regress the abovementioned individual, sociocultural, and structural factors on the emerging TL profiles. Two research questions underlying this study are:

1) In which profiles can Turkish school principals' TL practices be clustered?
2) To what extent are principals' gender, age, computer and internet usage in their daily tasks, schools' LO culture and ICT infrastructure able to predict these TL profiles?

METHODOLOGY

Research Population

The current study surveyed 1105 teachers and 58 principals from 69 public schools in an urban district of Istanbul city. Of the schools, 42% were primary schools (n=29), 32% were middle schools (n=22) and 26% were secondary schools (n=18). Almost in the same percentages, 41% of the teachers were sampled from the primary school level (n=456), 33% from the middle school level (n=363) and 26% from the secondary school level (n=286). About 38% of the Turkish school principals surveyed were primary school principals (n=22), 36% were middle school principals (n=21) and 31% were Fatih project secondary school principals (n=18).

As for gender demographics, the large majority of the principal participants (90%) were male principals (n=52), whereas about two thirds of the teacher participants (70%) were female teachers (n=745). These statistics are consistent with the general concern about the gender inequality in the distribution of school principals and teachers, as reported that 84% of principals are male, but 64% of teachers are female in Turkish schools (Women in Turkey, 2016). The average principal age was 48 years old (SD=8.83;

Minimum=31; Maximum=62) and the average teacher age was 40 years old (SD=8.80; Minimum=22; Maximum=69).

Procedures

Given the nested data structure with teachers clustered in schools, the sampling frame involved the multistage data collection procedures (Crano & Brewer, 2008). According to two-stage sampling design, the first stage is the selection of teacher units (i.e. schools). After obtaining an official research permission from the relevant district governorate, a total of 75 schools in the district became easily accessible to administer teacher and principal questionnaires. Yet, of these schools, 69 ones accepted to participate in our study, indicating 92% response rate at school level.

The second stage was to sample teacher participants. Thus, a ratio of 40% is used for each school to avoid oversampling teachers in small-size schools and undersampling them in large-size ones. As a rule of thumb, a sampling ratio over 30% is required for the research population of around 1.000 participants (Durrheim & Painter, 2006). Accordingly, a total of 1285 teacher and 69 principal questionnaires were administered in the participating 69 schools. After the elimination of missing and invalid data, 86% and 81% response rates were respectively achieved for teachers (n=1105) and principals (n=58).

Research Instruments

The principal questionnaire consists of two parts. In the first part, principal demographics of age and gender are collected through an open-ended form. Next, school principals are asked to rate their computer and internet usage duration on two items, whose options range from 1 (weekly 0-2 hours) to 5 (weekly 12 hours and more). At the end of the first part, they are also asked to mark whether they work in an ICT-enriched Fatih project school or not.

The second part of the questionnaire includes 32 items of the Technology Leadership Scale (TLS) developed by Banoğlu (2012). Scale items measure school principals' TL practices by five sub-scales based on ISTE standards (i.e. visionary leadership, digital-age learning culture, systemic improvement, excellence in professional development and digital citizenship). Principals' responses are rated on a 5-point likert-type measurement instrument ranging from 1 (never) to 5 (always). Sample items from these subscales are -for instance- "I consider important the presence of a school technology plan aligned witht he school strategic plan." (visionary leadership); "I make sure teachers design technology-enriched and

efficient lesson plans." (digital-age learning culture); "I ensure teacher involvement in professional development activities just as planned in the school technology and strategic plans." (excellence in professional practice); "I endeavor to collect qualitative and quantitative data with a view to assessing ICT using level in the school." (systemic-improvement); "I raise teacher awareness for ethical and lawful ICT usage that may be violated by students in their student homework and research." (digital citizenship).

The TLS demonstrated sound psychometric properties with respect to validity and reliability in the original scale development study (Banoğlu, 2012). In the original scale development study, Banoğlu reported that exploratory factor analysis (EFA) was conducted through varimax rotation since this rotation technique permits estimated factor loadings to become less correlated among factors but more homogeneous within each factor structure (Field, 2009; Tabachnick & Fidell, 2007b). Cronbach's α values pertaining to the sub-scales are found to be .93 for the visionary leadership standard, .91 for the excellence in professional development standard, .88 for the digital citizenship standard, .93 for the digital-age learning culture standard and .79 for the systemic improvement standard of TL. Having checked the normality of data, EFA results yielded a five-factor solution with factor loading ranging from .52 to .84 and those explained almost 65% of the total variance (KMO=.90; $p<.001$). After EFA procedures, the confirmatory factor analysis (CFA) was conducted to confirm construct validity of the five-factor solution. Following the recommendation of diversity about goodness-of-fit indices (Bollen & Long, 1993; Brown, 2015), three diverse model-fit indices were selected to endorse TLS's construct validity. These indices are the normed chi-square index (CMIN/df) for parsiminuous fitting, the comparative fitting index (CFI) for incremental fitting and the root mean square error of approximation (RMSEA) for absolute fitting. A general guideline for the interpretation is that a CMIN/df ratio of 5 or less, CFI value of .95 or more, and RMSEA value of .06 or less points out an acceptable model-data fit in social sciences (Hu & Bentler, 1999; Marsh & Hocevar, 1985). As a result, CFA produced satisfactory estimates, even though CFI value was slightly lower than the suggested cut-off point (CMIN/df=1.42; CFI=.91; RMSEA= .06).

The teacher questionnaire is also formed in two parts. The first part involves teacher demographics, such as gender and age. The second part includes 19 items of the Learning School Scale (LSS) developed by Çetin and Subaş (2014). Based on Dexter's (2008) assumption about ICT integration and associated three LO cultures (i.e. team learning, shared vision and systems thinking), teacher

participants were asked to response to three sub-scales on 4-point items with intervals ranging from strongly disagree (1) to strongly agree (4). Sample items from these sub-scales are “There is a goal congruence among school teams.” (team learning); “Our school vision includes well-defined success criteria.” (shared vision); “Organizational problems arise from the previous actions we have already taken.” (systems thinking).

For its psychometric properties, the LSS explains 59% of the total variance with changing factor loadings in the value range of .51 and .81 (KMO=.86; p<.001). Besides, Cronbach’s α coefficients were found to be .93 (team learning), .91 (shared vision) and .71 (systems thinking), indicating an acceptable internal consistency for sub-scales.

Data Analysis

Preliminary analyses were performed to assess the assumption of linearity, normality and heteroscedasticity of the collected data. The linearity assumption was visiually examined for standardized residuals of continuous variables by a scatter plot. Standardised residuals did not shape a curved line on the scatter plot, which indicates the evidence of linearity (Tabachnick & Fidell, 2007b). The heteroscedasticity assumption was also checked by the residuals of predicted and predictor variables. It was seen that scattering points did not form a funnel shape, otherwise it is a typical pattern of heteroscedasticity (Fidel, 2009). Normality of continuous predictor and outcome variables were evaluated through skewness-kurtosis and z values. Although skewness and kurtosis estimates were all above the threshold value of 2 in absolute terms (George & Mallery, 2010), we detected two outliers based on the z-values exceeding the critical value of 2.58 at 99% confidence interval (Field, 2009). Thus, data coming from two participants were excluded from the main analyses. Preliminary analyses were all carried out using SPSS 23.0 software.

For the main analysis, latent class analysis (LCA) was performed to establish TL profiles (i.e. sub-groups) by a probablistic approach. LCA is a multivariate clustering method to identify unobserved structures with a certain likelihood ratio (Samuelsen & Raczynski, 2013). In this study, LCA allows us to track the overall layout of TL practices by classifying principals into alike sub-groups. Later on, idependent variables were added into the model to investigate how they can predict a change in school principal’s TL practices by odds ratios produced by logistic regression analysis.

While conducting the main analyses, Mplus 7.23 statistical software was employed to calculate maximum likelihood with robust standard errors. To guard against the possiblity of local maxima, which

would indicate sample bias for the generated iterative model estimates (Hagenaars & McCutcheon, 2002), each model was estimated by 200 random sets of start values with 20 final stage optimization ("Mplus version history", 2012).

RESULTS

Descriptive findings presented in Table 1 show that teachers' perception of the "systems thinking" professional learning orientation obtain the highest mean score on the 4-point scale (M=2.99; SD=.54). Whereas their perception of the "team learning" obtains the lowest mean score (M=2.76; SD=.57). A similiar descriptive finding to emerge from the school principal dataset indicates that school principals report the highest performance in "digital citizenship" related TL practices (M=4.42; SD=.51), however, they perform "systemic improvement" related TL practices in schools with the lowest mean score (M=3.74; SD=.79). Table 1 indicates all descriptive and correlation estimates.

Table 1. Descriptive and Corelation Findings

	M	SD	(1)	(2)	(3)	(4)[a]	(5)[a]	(6)[a]	(7)	(8)	(9)	(10)
(1) Age	48.27	8.83										
(2) Internet usage	3.51	1.36	-.28*									
(3) Computer usage	3.98	1.16	-.21	.56**								
(4)[a]Team learning (LO)	2.76	.57	.25	.01	-.17							
(5)[a]Shared vision	2.81	.65	.09	.01	-.14	.88**						
(6)[a]Systems thinking (ÖÖ)	2.99	.54	.07	.07	-.10	.51**	.54**					
(7) Visionary leadership (TL)	4.07	.64	-.06	.16	-.10	-.07	-.13	-.11				
(8) Digital-age learn. cult. (TL)	4.15	.67	-.04	.21	.30*	.13	.12	-.04	.62**			
(9) Professional practice (TL)	4.04	.71	-.02	.18	.12	-.01	-.07	-.04	.86**	.68**		
(10) Systemic improv. (TL)	3.74	.79	.16	.26*	.10	.15	.07	.07	.68**	.69**	.75**	
(11) Digital citizenship (TL)	4.42	.51	.17	.27*	.25	.30*	.24	.01	.55**	.68**	.57**	.64**

[a]Aggregated teacher perception; *p: p<.05;** p: p<.01.

The correlation estimates reveal that there is a negative correlation between school principal's age and computer usage duration (r=-.28; p<.05). There is a positive and relatively strong correlation between computer and internet usage durations (r=.56; p<.01). Also we found that school principals' computer usage duraion is slightly associated with their "digital-age learning culture" TL practices (r=.30; p<.05).

Besides, school principals' internet usage duration is found to be slightly associated with their "systemic improvement" (r=.26; p<.05) and "digitial citizenship" TL practices (r=.27; p<.05).

As for the findings obtained from the correlational analysis of teacher dataset, all professional learning orientations were found to be interrelated. At most, "shared vision" and "team learning" professional learning orientations were found to be strongly associated (r=.88; p<.01). What is of interest to us is that teachers' mean perception of "team learning" aggrageted at school level has a cross-sectional and even moderate level relation with school principals' "digital citizenship" TL practices (r=.30; p<.05). In other words, the more principals pay attention to their "digital citizenship" TL practices, the more teachers perceive "team learning" school culture in their workplace, and vice versa.

Among five ISTE-A standards of TL practice, the strongest relationship was found between principals' "visionary leadership" and "digital-age learning culture" TL practices (r=.86; p<.001). Another high correlation was observed between their "excellence in professional development" and "systemic improvement" TL practices (r=.75; p<.01). All other standards of TL practice were found to be moderately associated with each other.

Latent Class Analysis

To identify the number and structure of diverse TL profiles assumed by Turkish school principals (see. research question-1), LCA was conducted to assign principals to classes based on their TL practices and using a probabilistic approach. For that purpose, we calculated -log likelihood (-LL), Akaike information criteria (AIC), Bayesian information criteria (BIC), class entropy (Ent.) and Lo-Mendell-Rubin (LMR) comparartive fit index for an iterative set of LCA models (Heck & Thomas, 2015). Table 2 shows alternative class structures alongside their respective indices.

Table 2. Latent Class Solutions and Fit Indices

Profil modelleri	-Log likelihood (-LL)	% Decrease in -LL	AIC	BIC	Ent.	LMR (k-1) test	p
One-class profile	248.78	-	517.57	537.82	1.00	-	-
Two-class profile	162.25	34.80	356.50	388.90	.96	166.19	.001

Three-class profile	144.32	11.05	332.65	377.21	.94	34.42	.22

Seeing that three-class model did not produce a significant decrease in the value of LMR (p=.22), the two-class model was interpreted to depict TL profiles in this study (-LL= 162.25; AIC= 356.50; BIC= 388.90; Entropy= .96; LMR= 166.19, p<.001). Figure 1 illustrates the determined two-class model with their five class indicators, i.e. ISTE standards.

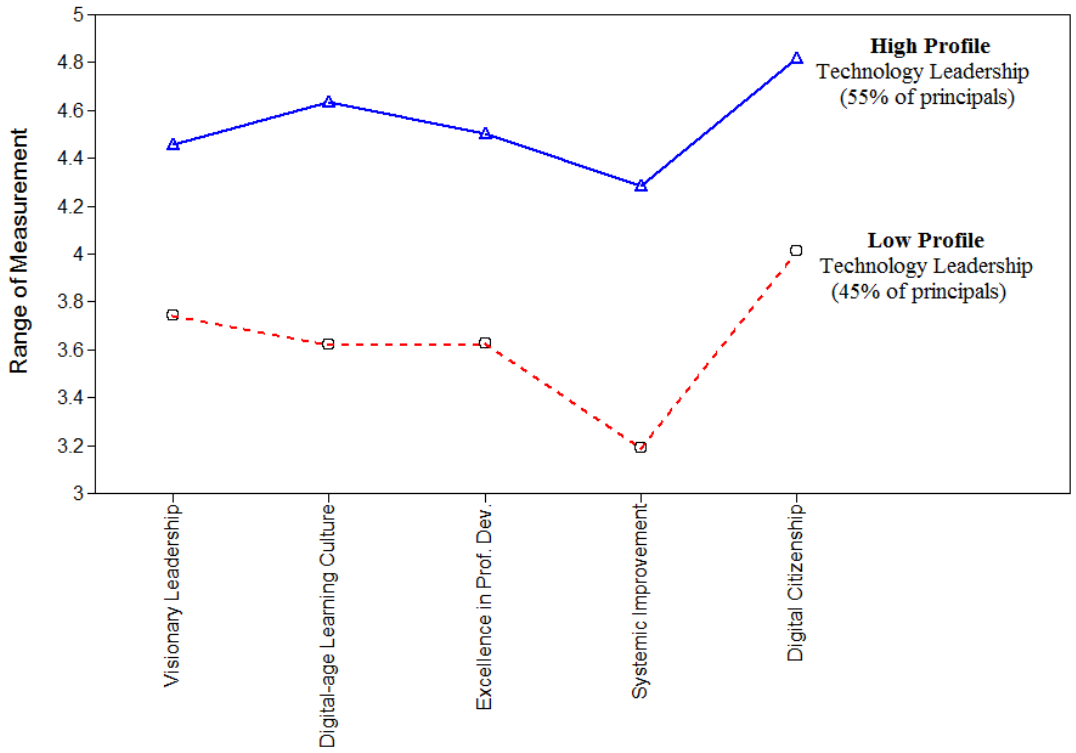

*Figure 1.*Technology Leadership Profiles

As illustrated in the Figure 1, the two-class model resulted in two diverse TL profiles. Based on their apparent level differences, we named these graphics as high and low level TL profiles. The high- level profile covers 55% of the principals, who pay clearly high attention to TL practices in all ISTE-A standards According to dispersion of ISTE standards, the “digital citizenship” standard regarding the execution of ethical and fair TL practices receives a great attention from the principals clustered in the high-level TL profile (M=4.82; SE=.05). However, the “systemic improvement” standard based on principals’ data-driven decision making and strategic partnership TL practices attracted relatively less attention of the related principals (M=4.28; SE=.08). As for the low-level TL profile, 45% of the principals

seemed relatively indifferent to perform all five ISTE standards of TL practice. An exception is that the“digital citizenship” standard proved to be a little bit above the others (M=3.94; SE=.06).

Logistic Regression Analysis

To examine the second research question, school principals' TL profiles (0= low-profile; 1= high-profile) were regressed on their age, gender, duration of computer-internet usage for daily tasks a week, aggregated teacher perception of the "team learning", "shared vision", "systems thinking" professional learning orientations of LO cultures, and school's Fatih project status variables. The low-level TL profile was determined as reference class for the logistic regression analysis. While interpreting, positive and significant regression coefficients point out predictor variables of school principal's TL practices that enhance the assignment probability of a principal to the high-level TL profile (see. Table 3).

Table 3. Technology leadership profiles regressed on the predictors

Predictors	High-profile TL (Outcome Variable)		
	B (SE)	*Odds Ratio (OR)*	*CI 95%*
Gender	- .10 (.35)	.91	.51-1.61
Age	.19 (.44)	1.21	.59-2.49
Computer usage	.46 (.42)	1.59	.80-3.16
Internet usage	1.26 (.56)*	3.53	1.41-8.80
Team learning (LO)	2.15 (.92)*	8.60	1.90-38.92
Shared vision (LO)	- .67 (.89)	.51	.12-2.22
Systems thinking (LO)	- .93 (.54)	.39	.16-.95
F@tih project schools vs others	3.25 (1.26)*	25.89	3.25-206.18

*p: p<.05;

The results indicate that the probability that a principal would be classified in the high-level TL profile is about four times higher than the one that principal is assigned to the low-level TL profile if he/she would use internet technology for a longer period of time a week (OR=3.53; 95% CI=1.41-8.80). To put it simply, we found that principal's internet usage duration is able to predict one's TL profiles very likely. The most striking results from this study is that principals are nine times more likely to perform a higher

level of TL practices in a school setting where teachers perceive a higher level of “team learning” profesional learning orientatio (OR=8.60; 95% CI= 1.90- 38.92). Even much more likely, the results show that principals who manage Fatih project schools with ICT-enriched classrooms are almost twenty-six times more likely to perform a higher level of TL practices as in the high-level TL profile, compared to non-project schools’ principals (OR=25.89; 95% CI= 3.25-206.18).

To sum up, ICT infrastructure was found to be the most strongest predictor of TL practices performed by Turkish school principals. Teachers’ perception of “team learning” as a partial proxy for school’s LO culture was found to be the second strongest predictor. Thirdly, the duration of internet usage appeared to drive up the probability of a principal to perform a higher level of TL practices.

DISCUSSION AND CONCLUSION

In the last couple of decades, national education systems invested a considerable amount of financial resource in the provision of widespread, equal and high-speed access to educational technologies in K-12 public schools (Blount, 2008; Dale, 2005; Kozma, 2005; Organization of Economic Cooperation and Development [OECD], 2006, 2010). Based on these public investments, national authorities launched a broad range of educational reform movements on ICT integration in many countries across the World. To give some examples, such as Apple Classrooms for Tomorrow Project in USA; Information Society Program in Finland; School IT Project in Mauritius; Smart School Project in Malaysian; Educational Reform for Knowledge Economy in Jordan, and Fatih project in Turkey (“Fatih Project”, 2012; Jhurree, 2005; Kankaanranta & Linnakyla, 2004). Beyond the monetary and technical magnitude of those projects, Anderson and Dexter (2005) noticed that principals’ TL practices and technology-oriented behaviors play a more important role in ICT integration processes than the provision of cutting-edge technological tools into schools.

It is obvious that not only infrastructral facilities are unique determinants of the success of ICT integration implementations, but also individual and sociocultural variables are in play (Tondeur et al.,2009; Vanderlinde et al., 2012). In this sense, it is known that there are considerable variations between principals in terms of their ICT use (Schiller, 2003), but yet their personal competence and frequency of ICT use improve their support to teachers for ICT integration in schools (Polizzi, 2011). Taking into account the sociocultural context, a positive school culture fostering team working, visionary approach and holistic perspective was stipulated to ensure the success of TL practices by many studies(Dexter, 2008, 2011; Tearle, 2004; Vanderlinde et al.,2012).

Drawing on all these individual, contextual and infrastructural factors together, our study adds to the literature from two main perspectives. First, the present study achieved to classify Turkish principals' TL practices into two distinct profiles that identify how and to what extent school principals engage in ISTE standards of technology. Of these profiles, the high-level TL profile covered 55% of principals with satisfactory interest to perform ISTE standards in schools; whereas, 45% of principals were ploted in the low-level TL profile since those showed a rather low interest in the same standards. These results are quite consistent with those of Samancıoğlu et al. (2015) study, in that Turkish principals were profiled as high-profile (66%) and low-profile (34%) technology leaders based on teacher views. However, unlike the current study, Samancıoğlu et al. (2015) investigated TL profiles without taking principal and school related factors into analysis. Thus, we can assert that our work challanged the issue from a more holistic point of view that involved all related factors.

The most striking result to emerge from this study suggests that Turkish school principals who run ICT-enriched Fatih project schools have a rather strong tendency to perform a higher level of TL practices. In other words, we clearly showed that Fatih project investment made a contribution to existing managerial capacity of schools alongside their infrastructural assets. This result supports Anderson and Dexter's (2005, p. 56) TL model which delineates the interrealted relationship between infrastructure and TL in schools. However, our findings provide additional probes into inndiviudal and sociocultural factors. As such, we showed that school principals come to the fore if they use internet in their daily task for a longer period of time, and if they work in a school with faculty who experience a higher level of "team learning" related LO culture.

In line with our findings, Banoğlu (2012) showed that the higher level of TL practice predicts the higher frequency of internet usage with a statistical accuracy rate of 68%. The present study confirms a similar relationship, but from a reverse angle, so that the longer duration of internet usage predicts the higher level of TL practice for school principals. Unlike Banoglu's results, the present study did not indicate any predictivity relationship between the computer usage and principal's TL practices. In parallel with our study, numerous other studies have drawn on the integrity of cultural and structural school characteristics as regard to TL practices performed in schools (Flanagan & Jacobsen, 2003; Tondeur et al., 2009; Vanderlinde et al., 2012). Although the complementary of collegial cooperation and team-based leadership practices were already observed in the previous case studies (e.g. Dexter, 2011;

Cuban, Kirkpatrick,& Peck, 2001), the findings in this study provided quantitative evidences to the literature.

Based on the present results, we concluded three implications for educational policy makers and practitioners as the following:

a) Gathering principals runing Fatih project schools and the others in the context specific TL meetings and workshops may improve experience sharing and dissemination of good leadership practices among principals.
b) In order to promote principals' TL practices, a broader internet usage among principals should be stimulated on virtual tools such as e-mails, social media groups and educational portals by official education policies.
c) Expanding technology-related professional learning networks among teachers may support principals to manage ICT integration process in a more effective way.

Despite having to do with exploratory nature of the clustering approach employed in the first research question (i.e. TL profiles), results derived from the second research question offer explanatory insights into the integrity of individual, sociocultural and structural factors on principals' TL practices. However, it is worth noting that TL practices are not confined to positional leadership power of a principal (Davies, 2010). Therefore, further research can concentrate on teacher-level TL practices with a more inclusive focus.

Another drawback concerns the internal validity of the study. Fatih project was restricted with some middle schools and all secondary schools as of the date of 2015.Therefore the results ignore the mediating effect of school-level variable on the prediction of principals' TL practices in the Fatih project schools. At last, the findings in this paper are limited with the investigation of few principal demographics and three LO components of school culture. It would therefore of interest to involve many other sociocultural and structural school characteristics in further research.

Besides, There were various strengths and weaknesses in this study. Some primary strengths can be listed as applied multilevel analyses and combining multipledata source coming from teachers and principals into a comprehensive research model. The most important weakness of the study was the relatively small school-level sample size of 58 school principals, compared to 1105 teachers aggregated in those schools.

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CHAPTER 3

ROLE OF SCHOOL PRINCIPALS' TECHNOLOGY LEADERSHIP PRACTICES IN SHAPING LEARNING ORGANIZATION CULTURE

Abstract

Various studies indicate that a principal's technology leadership (TL) practices can facilitate ICT integration into K-12 schools provided that a drastic change in teachers' organizational behaviors occurs. However, there has been little empirical evidence on how these practices contribute to such change in the school culture, for instance, the learning organization (LO) culture stimulating teacher's individual and collective professional learning orientations in tandem. Therefore, the aim of this study is twofold. The first goal is to identify distinct profiles of LO culture in schools based on teachers' professional learning orientations. The second is to explore how a principal's TL practices are related to teacher endorsement of these LO profiles. Data were drawn from 1,105 teachers and 58 principals in 69 public K-12 schools. Multilevel latent class analysis was applied to elucidate LO profiles with similar professional learning orientations, taking into account teacher-related (gender, age, years at current school) and school-related (number of students, educational stage) variables, as well as cross-sectional TL measures. Our findings show that teachers fell into three profiles of LO culture according to their professional learning orientations: creative tension (high level), realistic approach (moderate level), and emotional tension (low level). In the prediction of the creative tension profile, the principal's TL practices including data-driven decision making, networking, and ICT skilled staff employment played a significant role. Also, a school's educational stage and teacher's age were associated with teacher endorsement of creative tension. Beyond technology-related consequences, a principal's TL practices have far-reaching implications for teachers' professional learning culture.

INTRODUCTION

School leadership is essentially a matter of organizational change (Fullan, 2007). What is a fundamental flaw in most organizational change initiatives is that the education policy focuses on innovations and respective outcomes rather than on an understanding of how the larger organizational culture, structure, and norms will react to these innovative efforts (Senge et al., 1999). Likewise, technology leadership (TL) is a matter of organizational change ensuring ICT integration into school settings and relevant school culture (Dexter, Richardson, & Nash, 2017). We can outline two types of organizational changes coupled with the integration of ICT into school settings: 1) pedagogical innovations that are observable in teacher behaviours seeking enhancement in the use of ICT for instructional ends, and 2) sociocultural transformation of organizational behaviours in response to ICT integration implementaions at school level (Dexter, 1999; Langer, 2011; Venkatesh, 2003).

Toward a better understanding of the cultural transformation aspect, the learning organization (LO) theory advocated in this paper provides crucial insights into structural and cognitive transformation processes in school culture that are amenable to principal leadership (Senge et al., 2010). To that end, this study investigates the interplay between principals' TL practices and existing LO culture in schools. It is assumed that LO culture plays a significant role in supporting ICT integration efforts championed by TL practices (Anderson & Dexter, 2005; Cakir, 2012; Dexter, 2008; Dexter et al., 2017; Law, Yuen, & Fox, 2011; Sheppard, Brown, & Dibbon, 2009).

Except for a few case studies, the relationship between LO and TL has received little attention in quantitative empirical studies (Dexter & Anderson, 2002; Divaharan & Ping, 2010; Sheppard, 2003). While technology-related consequences of TL practices have been widely studied in the scope of TL research, the concept of LO culture has been unable to move beyond being a rhetorical argument thereof (Anderson & Dexter, 2005; Davies, 2010; Dede, 1994; Flanagan & Jacobsen, 2003; Tearle, 2003, 2004; Tubin, 2006; Yuen, Fox, & Law, 2004).

The understudy of LO culture with regard to TL practices is not coincidence but rather, at least in part, attributable to the prevailing understanding of educational technology, as if ICT were involved in the education system as a simple extension of other instructional tools that are traditionally prevalent in classrooms (Brooks, 2011; Kruger-Ross, 2013). From the viewpoint of this *technical approach*, ICT has little value in itself. Rather, it has idiosyncratic ends that are created and controlled through conscious human action (Feenberg, 1999).

Yet, the main premise that undergirds these views is fundamentally flawed because, once it is considered value-neutral, ICT becomes merely a technical facilitator of instructional preparation and delivery processes (Inan & Lowther, 2010). In that case, the ultimate outcome expected from ICT integration is the effective use of educational technologies in teaching and learning activities with a view to enhancing student achievement at the outside (Chen, 2011). However, often overlooked in the technical concern about instructional mediums is that ICT integration is subject to a complexity of social and cultural dynamics operating in the workplace environment (Frank, Zhao, & Borman, 2004).

In contrast, Feenberg (2001) criticizes the main logic underlying the technical approach above, suggesting that long-lasting debates over educational technologies must be reframed in a broader sociocultural context that goes far beyond the technology utility of ICT in pedagogical processes. More vehemently, Selwyn, Nemorin, Bulfin, and Johnson (2016) assert that there exists an almost pathological focus on pedagogical ends to be enabled, assisted, enhanced, or even transformed by ICT. A main drawback to this kind of technical approach is that its advocates tend to underestimate the growing value of social contexts and organizational structures, leaving them understudied. Instead, when educational policy makers and practitioners recognize the sociocultural value of ICT in contributing to creative thinking and problem-solving skills, the workplace culture that emerges can trigger drastic changes in teachers' professional learning (Kennewell, Parkinson, & Tanner, 2000). Then, passing beyond being simple mediums and facilitators of instructional activities, ICT holds socially specific values that might enable, limit, or alter existing organizational structures, social relations, cultural beliefs, and learning experiences in schools (Gratham, 2009). In this way, not only does ICT buttress teachers' efforts to reach some pre-planned instructional ends but also it cultivates the whole school community with genuine cultural values about *the learning itself* (MacGilchrist, Myers, & Reed, 2004). ICT is therefore capable of exerting an impact on teachers' organizational behaviors with regard to professional learning, and these changes ultimately affect school culture (Murgatroyd & Couture, 2010).

As mentioned, this study presents support for this kind of sociocultural standpoint and challenges to the aforementioned technical approach. Alternatively, we assume that TL practices may have a far-reaching sociocultural extensions on teachers' organizational behaviors as part of holistic school culture, that is to say, LO culture (Dexter, 1999, 2006, 2008, 2011; Divaharan & Ping, 2010; Law et al., 2011). In this sense, we herein refer to ICT integration as a cultural renovation instead of an instrumentalist innovation (Feenberg, 2001) because ICT integration is ideally meant to support a new kind professionalism among

teachers, which enhances both critical inquiry and collaborative working practices as well as ICT adoption (Dexter, 2008; Divaharan & Ping, 2010; Kennewell et al., 2000; Law et al., 2011; Murgatroyd & Couture, 2010; Tubin, 2006).

Learning Organization Culture

LO culture came to exist through ever-growing "professional learning" processes rather than as a consequence of pre-planned "professional development" trajectories (Senge, 1990), since the latter are usually predicated on structured training programs or one-time technical workshops carried out at the expense of teachers' own professional learning orientations germane to the school context (Pedder & Opfer, 2013). Outside the forceful legislation, fiats, commands, or official regulations, LO culture can appear in schools only through the adoption of learning orientations (Senge et al., 2000). Senge and his colleagues (2000) make sense of these orientations in terms of *five disciplines*: teachers' active engagement in generative dialog with other colleagues (i.e., team learning); collective aspiration for school values (i.e., shared vision); critical inquiry (i.e., systems thinking); professional growth (i.e., personal mastery); and self-reflection (i.e., mental models).

It has long been noted that LO culture essentially operates in individual (self-directed) and collective (school-based) realms in concert (Confessore & Kops, 1998; Nissila, 2005; Uibu, Kaseorg, & Kink, 2016). Out of the five learning orientations, personal mastery and mental models reflect self-directed professional learning orientations by which teachers hold individual control over their professional learning processes, formulating independent opinions and alternative routes for professional growth (Confessore & Kops, 1998). On the other hand, team learning and shared vision embody school-based orientations since they entail a common path toward collective vision that allows teachers to collaborate with their peers (Uibu et al., 2016). Overarching to LO culture is maintaining the systems thinking orientation that binds both self-directed and school-based orientations into an integrated school culture (Senge et al., 2000). None of the single professional learning orientations can represent LO culture by itself (Senge, 1990).

With regard to the antecedents of LO culture (cf. Argyris & Schön, 1978; Crossan, Lane, & White, 1999; Hedberg, 1981; Huber, 1991; Senge, 1990), the existing literature has identified effective leadership as a prerequisite for all these orientations (Liljenberg, 2015). It is widely accepted that principal leadership can stimulate teachers' individual and collective learning orientations as these promote social interaction among teachers (Frank et al., 2004), a shared school vision (Kurland, Peretz, & Hertz-Lazarowitz, 2010),

teacher participation (Liljenberg, 2015), and hence, an overarching LO culture in schools (Mulford, Silins, & Leithwood, 2004; Silins, Mulford, & Zarins, 2002). Further, the growing presence of ICT facilities that are more omnipresent and advanced in schools increases self-paced and collaborative professional learning orientations in organizations (Brandi & Ianonne, 2015; Margaryan & Littlejohn, 2014). Dexter, Richardson, and Nash's (2017) literature review similarly concluded that TL practices are essentially meant to support teachers' professional development, facilitating organizational change and the resulting LO culture in schools. However, research has not yet empirically investigated which particular TL practices are associated with teachers' professional learning orientations and the related LO culture.

Technology Leadership: Nuances and Reflections

In general, TL research can be divided into two distinct streams, that is, an (educational) technology-centered stream and a (school) leadership-centered stream (Jameson, 2013; McLeod & Richardson, 2011). In adherence to the aforementioned technical approach, the first stream sets a particular focus on technological advancements. It vastly deals with new leadership dispositions empowered by technology-mediated school environments, calling TL "e-leadership" or "virtual leadership" (e.g., Blau & Presser, 2013; Gurr, 2000, 2004; Gurr & Broadbent, 2004; Jameson, 2013; LaFrance & Beck, 2014; Richardson, LaFrance, & Beck, 2015). The technology-centered stream posits that cutting-edge instructional technologies and e-learning environments drastically transformed leadership roles in the 21st century (Gurr & Broadbent, 2004). Within this assumption, technology-centered TL research pays more attention to the interplay between technology take-up and the required new leadership competencies (Avoloio, Kahai, & Dodge, 2000).

On the other side, the leadership-centered stream shifts emphasis from the term "technology" to "leadership," with a holistic school improvement perspective on organizational structure and culture in schools (Anderson & Dexter, 2005; Dexter, 2011; Dexter & Anderson, 2002; Tearle, 2003, 2004; Vanderlinde, Dexter, & van Braak, 2012). In this account, Leithwood and Reihl (2005) define school leadership as "the works of mobilizing and influencing others to articulate and achieve the shared vision and goals in schools" (p. 14). School leadership encompasses three sets of tasks that principals are mainly responsible for: setting direction, developing staff qualifications, and redesigning working structures. In compliance with these tasks, Dexter (2008) draws an analogy between TL and school leadership that points out the following shared elements: 1) building a shared technology vision, 2) supporting a technology-related professional learning environment, and 3) keeping ICT tools and

technical support available to the whole school community. The leadership-centered approach tends to emphasize collegial relations and structural school features over the expedient function of ICT for individual teachers and students. Thus, TL practices gain a transformative meaning in reframing school culture and teacher praxis on the whole (Davidson & Olsen, 2003; Sheppard et al., 2009).

In recognition of the leadership-centered understanding in building a change culture in schools, the International Society for Technology in Education for Administrators (ISTE-A) framework was released for evaluation and self-evaluation of principals' TL practices (ISTE-A, 2009). The five sets of standards proposed by the ISTE are deemed of relevance to LO culture. They are also widely acknowledged to have some logical extensions to the leadership-centered approach advocated by LO theory (Dexter, 2008; Dexter et al., 2017; Law et al., 2011; Maddin, 2014; Moyle, 2006; Sheppard et al., 2009; Watts, 2009).

These five sets of standards are "visionary leadership," "digital-age learning culture," "excellence in professional practice," "systemic improvement," and "digital citizenship." *Visionary leadership* accounts for a school principal's visionary and planning practices that promote in-school collaboration and team working conditions. *Digital-age learning culture* covers a school principal's instructional leadership practices that encourage teachers to adopt ICT for meeting students' diverse needs. *Excellence in professional practice* draws on a school principal's performance in facilitating professional development and ICT-mediated communication throughout the school. *Systemic improvement* focuses on a school principal's managerial and data-driven decision-making practices that challenge evidence-based and strategic thinking performance. *Digital citizenship* taps into a school principal's ethical and moral practices that ensure legal, safe, and fair ICT use.

In Pursuit of the "Creative Tension"

Once a new technology is introduced into a school setting, multiple conflicts and contradictions may arise even in the most compatible school culture (Laferriere, Hamel, & Searson, 2013). Despite being loaded with imminent tensions, those conflicts may also pave the way for supporting LO culture in schools when certain leadership practices would encourage the teacher community to foster teachers' individual and collective professional learning orientations (Dexter et al., 2002; Dexter, 2008; Kurland et al., 2010). Yet, when school staff members fail to unite around a common interpretive framework and key purposes, the resulting discontinuities can solidify in the form of structural conflicts in schools (Pedder & MacBeath, 2008).

To deal with undesired ends of structural conflicts, Senge (1990) and Fritz (1989) define three types of strategies to follow, namely, creative tension strategy, emotional tension strategy, and realistic approach strategy. Persons adopting the creative tension strategy are prone to pull their professional growth levels up in the direction of visionary expectations. The emergent aspiration provides these people with a positive stimulus that urges them to change their existing mental models (Senge, 1990). While doing so, they heed the call of their willpower (Fritz, 1989). In pursuit of such creative tension, the first resolution strategy draws on new thinking and working patterns inasmuch as increasing personal mastery gears one toward a higher vision like ICT integration. Thus, the recursive dissonance between a teacher's own personal mastery and perception of a shared vision may prompt him or her to leverage LO culture in a "school that learns" (Senge et al. 2000).

Emotional tension is another strategy that lowers one's perception of a shared vision downward so that one can deal with the related dissonance without increasing his/her personal mastery (Flood, 1999). A person adopting this strategy prefers to overrate existing structural conflicts by interposing a negative vision and unwanted consequences at large (Fritz, 1989). When faced with pressure to change, people using this strategy do not hesitate to further lower their negative vision, for the sake of temporary relief (Senge, 1990). Under these circumstances, structural conflicts lead to emotional tension over time, and then the lack of belief in a shared vision gives rise to a sense of being misled among the organization's members, making change difficult if not impossible (Fritz, 1989).

The realistic approach strategy motivates its followers to stay in a tolerable conflict area outside the creative and emotional tensions, where they feel comfortable with a modest level of professional growth needs and visionary goals (Sparks, 2002). Indeed, it is a conflict mitigation strategy called the realistic approach, or idiomatically speaking, the "Don't rock the boat" or "Don't make waves" approach (Fritz, 1989; Sparks, 2002). Keeping personal reality and change-oriented expectations in equilibrium, people following the realistic approach intend to tolerate emerging structural conflicts under the pretext of being "practical" (Fritz, 1989) or sensibly "reasonable" in staying with the status quo (Somekh, 1996). Yet under the surface, they look for the easiest pathway to overlook threatening emotional tensions as though there were no problem concerning themselves and no bad news about the future of their organizations (Senge, 1990).

Unlike the other two, creative tension grasps a significant potential for arousing a sense of creativity in schools so that teachers can choose to support a systemic change "under their own terms" (Craft, 1997,

p. 92). Faced with a change agenda like ICT integration, however, teachers may be reluctant to abandon their present methods of thinking and learning, especially ones that have worked well in the past (Senge et al., 2000). The most obvious reason for such persistence is the fact that deeply held mental models and socially constructed visionary perceptions reinforce teachers' commitment to the traditional image of oneself and school culture (Dexter, 1999). Therefore, one of the core responsibilities of a school principal, beyond securing ICT assets for schools, is to turn the structural conflicts arising from pressures surrounding change into an opportunity for a holistic cultural change throughout the school (Senge et al., 2000).

Research Purpose

As noted earlier, the current body of school improvement literature provides little guidance related to the relevance of TL practices to teachers' professional learning orientations (Dexter et al., 2017). Further, it remains unclear which specific profiles of LO culture exist in public K-12 schools, based on teachers' professional learning orientations. Drawing on sociocultural consequences of ICT integration over organizational behaviors such as the emergence of creative tension, the current study brings into focus teachers' professional learning orientations with a particular reference to LO theory. To that end, the following two research questions are addressed in this study:

Research question 1: What are the distinct profiles of LO culture endorsed by teachers?

Research question 2: To what extent are principals' TL practices related to emergent LO profiles?

For answering these research questions, teachers' professional learning orientations were profiled to reveal some distinct profiles of LO culture. Then, the perceived LO profiles were regressed on the principals' TL practices across the schools.

METHODOLOGY

Research Population

Data were drawn from 1,105 teachers and 58 school principals from 69 schools in an urban district Istanbul city, Turkey. Of the school principals, 89.66% are male and 10.34% are female (age: M = 48, SD = 8.82, min = 31, max = 62). About one-third of the principals hold a post-graduate degree in educational sciences.

Of the teachers, 30.31% were male and 69.69 % are female (age: M = 40, SD = 8.80, min = 22, max = 69). With regard to the distribution of the teachers by grade, 40.27% taught at the primary school level (*N* = 445), 32.85% at the middle school level (*N* = 363), and 26.88% at the secondary school level (*N* =

297). On average, the teachers had taught for 4.72 years at their current school (SD = 4.78; min = 1; max = 32). This average nearly corresponds to the compulsory school service period in Turkey because, as per Turkish Education Law, a state-worker teacher cannot move to a new public school without completing a three-year compulsory service at his/her last school. In other words, the descriptive statistics show that most Turkish teachers move to a new school a few years after completing their compulsory service period.

Sampling Procedure

Given the nested data structure (i.e., teachers nested within the schools) and multilevel analysis thereof, a multistage cluster sampling procedure was carried out to construct teacher and school datasets separately (Crano & Brewer, 2008). In the first stage, teachers, i.e., lower level units, were grouped into schools, i.e., higher level units. The number of lower level units was drawn from the teacher population at each school, ensuring a proportional sample size. The total number of schools in the Maltepe district was 72 higher level units with an average teacher population of 47 teachers per school. Following Hox's (1998) rule of thumb for the multistage sampling of 20 observations for 50 groups, a sampling proportion of 2:5 was found to be appropriate. Then, 1,285 teachers and 72 principals were requested to fill out the questionnaires. Responses were received from 1,105 teachers and 58 principals, yielding response rates of 86% and 81% respectively.

Research Instrument

*Principal questionnaire***.** The principal questionnaire consisted of two parts. The first part collected descriptive data on the school background variables such as school size (i.e., number of teachers) and educational stage (i.e., primary, middle, or secondary). A growing number of studies have argued that school size might be associated with TL practices (Dawson & Rakes, 2003; Dexter, 2006; Dexter, Louis, & Anderson, 2010) and LO characteristics (Leithwood, Leonard, & Sharatt, 1998; Louis & Murphy, 2017; Mulford et al., 2004). Therefore, schools' educational stage is usually controlled in the assessment of TL (Anderson & Dexter, 2005; Dawson & Rakes, 2003) and LO characteristics (Leithwood et al., 1998; Marks & Louis, 1999).

The second part of the principal questionnaire contained 32 items from the Technology Leadership Scale (TLS) developed by Banoğlu (2012), which is grouped into five subscales that measure a principal's TL practices according to the ISTE-A (2009) framework. These subscales measure a principal's TL practices through self-report questions on visionary leadership, digital-age learning

culture, excellence in professional practice, systemic improvement, and digital citizenship behaviors. The ISTE-A framework was chosen for two practical reasons. First, the ISTE-A standards have largely been viewed as robust performance indicators for assessing school improvement (Richardson & McLeod, 2012). Given that this study was conducted on a population of Turkish educators, the second, practical reason for using the ISTE-A standards was their wide recognition among Turkish scholars (Hacıfazlıoğlu, Karadeniz, & Dalgıç, 2010, 2011; Orhan, Kurt, Ozan, Vural, & Türkan, 2014; Sincar, 2013).

Sample items from the TLS subscales are "I care about the school technology plan as a part of the school strategic plan" (*visionary leadership*), "I ensure teachers design technology-enriched and efficient lesson plans" (*digital-age learning culture*), "I ensure teacher involvement in professional development activities, as situated in the school technology plan" (*excellence in professional practice*), "I endeavor to collect qualitative and quantitative data with a view to assessing the effect of ICT implementations in the school" (*systemic improvement*), and "I raise teacher awareness about internet plagiarism that may be seen in student homework and research" (*digital citizenship*). The principals gave their responses on a 5-point Likert scale ranging from 1 (never) to 5 (always). All TLS subscales demonstrated a good internal consistency with Cronbach's α coefficients ranging from .72 to .94.

Teacher questionnaire. The teacher questionnaire contained two parts. The first asked three questions to gather information on the teacher's gender, age, and number of years teaching at his/her current school. These descriptive variables usually are treated as control variables to investigate their confounding effect on LO culture in schools (Garcia-Morales, Lopez-Martin, & Llamas-Sanchez, 2006; Leithwood et al., 1998; Mulford et al., 2004).

In the second part of the questionnaire, the Learning School Scale (LSS) by Çetin and Subaş (2014) was used to measure LO culture using the teachers' professional learning orientations. The 30 LSS items are constructed around five subscales, based on Senge's (1990) five LO disciplines. Two subscales contain self-report measures on a teacher's *personal mastery* (e.g., "I am willing to join professional development activities") and *mental models* (e.g., "I respect differences of opinion as a learning opportunity for me"). Two other subscales assess teacher endorsement of workplace routines and the school vision in terms of *team learning* (e.g., "There is goal congruence among teacher teams") and *shared vision* (e.g., "Our school vision includes well-defined success criteria"). Finally, the *systems thinking* subscale gauges the presence of an overall mindset that draws on organizational cohesion and

a comprehensive viewpoint (e.g., “Organizational problems arise from the previous actions we took”). Teacher responses are scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The internal reliability of the subscales was adequate, with Cronbach’s α coefficients ranging from .77 to .92.

To provide justification for the aggregation of LSS subscales at the school level, intraclass correlation coefficients ICC(1) and ICC(2) were calculated for the five LSS subscales. ICC(1) coefficients manifest the agreement levels of teachers on the aggregated school means. ICC(2) accounts for the reliability of those means (Kleine et al., 2000). In percentage terms, ICC(1) coefficients also indicate the proportion of variance between school groups (Heck & Thomas, 2015). In their review of ICC(1) coefficients, Hedges and Hedberg (2007) stated that the variance proportion explained by school groups generally changes in the range of 5–25 percent. For this study, school membership explained almost 6 percent of the total variance in the personal mastery subscale (ICC(1) = .06); 8 and 6 percent, respectively, of that in the mental models and systems thinking subscales (ICC(1) = .08; ICC(1) = .06); 11 percent of that in the shared vision subscale (ICC(1) = .11); and 6 percent of that in the team learning subscale (ICC(1) = .06). Estimated ICC(2) coefficients provided plausible support for the reliability of ICC(1) coefficients in the value range of .85–.94, which are above the suggested threshold value of .70 (Dixon & Cunningham, 2006; Klein et al., 2000). Thus, the TLS subscales were all found to be appropriate for aggregation in multilevel analysis.

Data Analysis

Multilevel latent class analysis (MLCA) was used to conduct a two-stage data analysis. In the first stage, it was investigated which latent LO profiles were endorsed by teachers (Research Question 1). Therefore, teachers were clustered into distinct LO profiles based on their professional learning orientations. During the second stage of the MLCA, it was investigated which TL practices were related to the emergent LO profiles (Research Question 2). More specifically, the identified LO profiles were regressed on principals’ TL practices and teacher and school demographics.

*Multilevel latent class analysis***.** MLCA is a robust statistical method used to identify underlying profile structures in data, based on the observed variables clustered with a certain likelihood ratio (Samuelsen & Raczynski, 2013). The identification of the underlying latent structures can be used to uncover cultural group profiles whose members are likely to share similar perceptions (Eid, Langeheine, & Diener, 2003), such as profiles of LO culture endorsed by teachers in this study. Not only does MLCA draw inferences

about the number and content of group profiles, but it can also calculate the probability of group membership for individuals (Palardy & Vermunt, 2010). Moreover, where the data structure is hierarchical with individuals (e.g., teachers) nested in measurement units (e.g., schools), MLCA may set free latent class intercepts to vary across measurement units (Henry & Muthen, 2010). Thus, it allows factoring of prospective unit-level characteristics within individual-level latent structures (Muthen & Asparouhov, 2009).

From the technical aspect, MLCA is quite similar to any other clustering analysis because all clustering algorithms aim at classifying observed measurements under a set of unobserved sub-groups. However, as distinct from other clustering methods that use distance measures (e.g., K-means, hierarchical cluster analysis), MLCA utilizes probabilistic statistics to classify participants into sub-groups (Vermunt & Magidson, 2002). MLCA is a finite mixture modeling approach that taps into model-based estimations, allowing researchers to test all parameters by using normal distribution functions (Wedel & DeSarbo, 2002). Thus, MLCA relieves researchers of making *a priori* and subjective decisions about clustering distances (Magidson & Vermunt, 2002). Secondly, and of the most importance to us, MLCA allows researchers to use a multilevel conditional model in conjunction with potentially moderating variables such as TL practices, and teacher and school demographics.

Stage 1: profiling. In this study, MLCA is predicated on two different analytical stages tailored to unconditional and conditional regression models. Firstly, unconditional regression models with fixed and random effects were tested to identify the number and structure of the latent profiles that produced significantly better model-data fitting indices. In this first stage, the fixed-effect models contained a constant (intercept) term and fixed slopes. Thus, the mean scores obtained from the five LSS subscales were specified as latent class indicators of fixed slopes. Starting from the initial unconditional model with a single class, successive sets of fixed-effect equations were tested to achieve the best data-model fitting indices. For each model, the model-data fit was interpreted using negative log-likelihood, class entropy, Akaike information criterion (AIC), Bayesian information criterion (BIC), and Lo-Mendell-Rubin likelihood parameters (Henry & Muthen, 2010). Higher level class entropy with a significant decrease in negative log-likelihood, as well as AIC and BIC values represents a better model-data fit (Wedel & DeSarbo, 2002). Following the recommendation of Lo, Mendell, and Rubin (2001), iterative processing was continued until the Lo-Mendell-Rubin likelihood test was insignificant for the model in question. The

last significant fixed-effect model was further analyzed for its random-effect models to reveal the final class structure of the latent profiles.

Stage 2: prediction. Next, a conditional model with randomized latent class structure was analyzed through logistic regression analysis, as depicted in Figure 1 (cf. Henry & Muthen, 2010, p. 198, Figure 3). Teacher-level characteristics (i.e., gender, age, years at current school) and school-level characteristics (i.e., TL practices, number of students, and educational stage) are simultaneously entered in the conditional model as predictive variables. Observed measurements are drawn with rectangles that represent class indicators. The large circles represent common latent class factors, and the two little circles represent randomized profile means. The MLCA models were all estimated using the maximum likelihood estimation with robust standard errors in Mplus 7.2 (Muthen & Muthen, 2012).

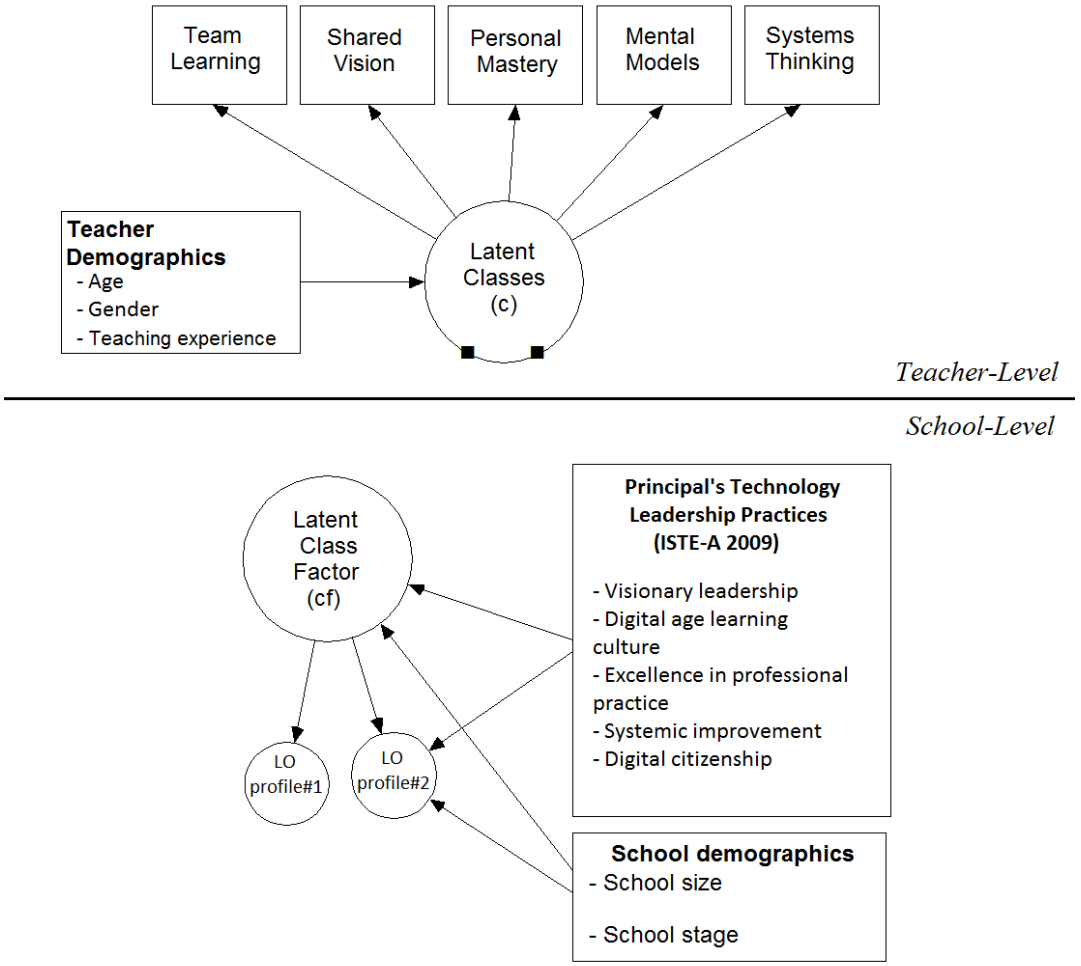

Figure 1. Conditional model with potential predictors.

RESULTS

Research question 1: What are the distinct profiles of LO culture endorsed by teachers?

To identify the best-fitting latent class structure with regard to LO culture, we calculated −log likelihood (−LL), AIC, BIC, class entropy (Ent.), and Lo-Mendell-Rubin (LMR) test results for an iterative set of LCA models (see Table 1). In comparison with the three-class solution fixed-effects model in the third row, the four-class solution fixed-effects model in the bottom row did not cause a significant improvement in LMR test results (p = .30). Notably, the three-class solution yielded the least significant decrease in -LL, AIC, and BIC coefficients according to the LMR test (p < .001). Therefore, we interpreted only the three-class fixed-effects solution below (−LL = 2,792.61; AIC = 5,629.22; BIC =5,732.58; Entropy = .81; LMR = 273.74, p < .001). Table 1 shows all parameter estimates for the latent class solutions.

Table 1. Latent Class Solutions and Fit Indices

Number of Classes	*Models*	*−Log likelihood (−LL)*	*AIC*	*BIC*	*Ent.*	*LMR (k-1) test*	*p*
One-class solution	Fixed effects	3353.77	6727.53	6774.51	1.00	n/a	n/a
Two-class solution	Fixed effects	2932.89	5897.77	5972.95	.77	821.32*	<.001
Three-class solution	Fixed effects	2792.61	5629.22	5732.58	.81	273.74*	<.001
	Random effects	2772.78	5595.57	5713.03	.80	n/a	n/a
	Random effects with a factor	2774.86	5597.73	5710.48	.80	n/a	n/a
Four-class solution	Fixed effects	2697.09	5450.17	5581.72	.82	186.41	.30

The random-effects models listed in Table 1 are based on individual random intercepts (i.e., teachers' membership probability for a profile) that vary across schools. When the three-class solution with the related random-effects model was specified, the estimated entropy value remained almost the same in comparison with that of the fixed-effects model (Ent. = .80). Following the recommendations of Henry and Muthen (2010), one common factor was further added to the model so that different random

intercepts would be allowed for different factor loadings and then computation time would be reduced to a large extent. Adding a common factor acknowledges that all random indicators (i.e., professional learning orientations) are highly correlated and hence can be represented by a single assignment factor. The correlation coefficients between .33 and .70 confirmed that the professional learning orientations all were significantly associated. Whether the underlying assumption for a common factor is met, is further justified by the detection of any reduction in the model-data fit indices without decreasing the entropy value (Henry & Muthen, 2010). Our random-effects model with a common factor brought the BIC parameter down somewhat (BIC = 5,710.48) while maintaining the previous entropy value of .80 (see Table 1). As a result, the three-class solution random intercepts with a common factor model yielded three distinct profiles of LO culture, as illustrated in Figure 2.

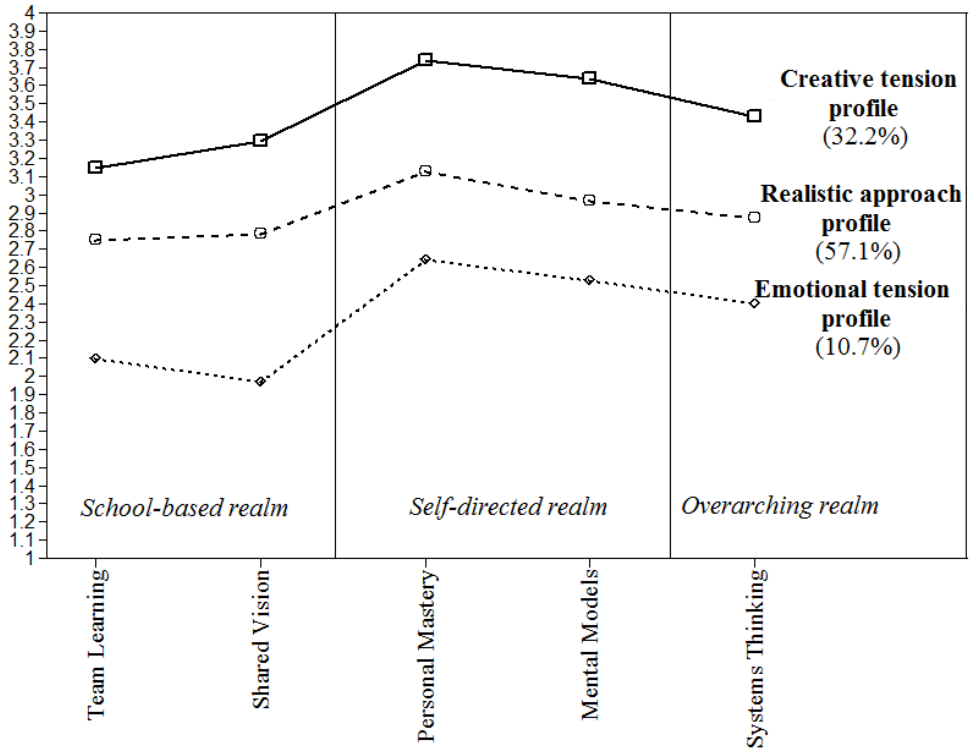

Figure 2. Learning organization profiles with five professional learning orientations.

The results in Figure 2 indicate that the three-class solution falls into three different levels with similar rises and falls. Note that there are clear mean differences between the self-directed and school-based professional learning orientations. This disparity provides a basis for the conceptualization of structural conflicts that are distinguished in the LO theory by Senge (1990) and Fritz (1989). Based on the above

discrepancy between relatively low level school-based orientations and higher level self-directed orientations, we identified three LO cultures, which we call the creative tension, realistic approach ("Don't rock the boat/Don't make waves"), and emotional tension profiles.

Teachers involved in the creative tension profile (32.2%) reported their personal mastery (M_{class3} = 3.73; SD = .02) and mental models (M_{class3} = 3.63; SD = .03) orientations at the highest level. Conversely, in this profile, school-based team learning (M_{class3} = 3.11; SD = .10) and shared vision (M_{class3} = 3.26; SD = .11) orientations had the lowest scores. The overarching systems thinking orientation kept the balance between teachers' self-directed and school-based orientations (M_{class3} = 3.42; SD =. 04).

Secondly, the realistic approach profile, which included over half of the total teacher sample (57.1%), leveled off in the middle ground and varied comparatively less across the latent class indicators. Team learning (M_{class2} = 2.73; SD = .04), shared vision (M_{class2} = 2.75; SD = .05), and personal mastery (M_{class2} = 3.11; SD = .04) were nearly identical to their overall sample means. However, these orientations fell behind the overall sample in mental models (M_{class2} = 2.95; SD = .04) and systems thinking (M_{class2} = 2.87; SD = .03) orientations.

Thirdly, the emotional tension profile, which had the smallest teacher group (10.7%), had the lowest mean scores but by far the largest interrelated variance in vertical line. The teachers in this profile had a low mean of team learning (M_{class1} = 2.10; SD = .09), even lower shared vision (M_{class1} = 2.00; SD = .09), slightly increasing personal mastery (M_{class1} = 2.56; SD = .13), then a little decrease in mental models (M_{class1} = 2.47; SD = .09), and fully centered systems thinking (M_{class1} = 2.30; SD = .12) mean.

To evaluate to what extent school contexts might be involved in teachers' perceptions, maximum likelihood variances were estimated across schools for each profile. The results showed the variance of teacher perception of creative tension yielded a strong degree of heterogeneity across schools ($V(U_{0j})$ = .95; SE = .43; $p < .05$). That is to say, schools varied significantly in their probability that a teacher would perceive creative tension therein. Likewise, variance estimates of the random intercepts concerning emotional tension were significantly heterogeneous ($V(U_{0j})$ = 1.87; SE = .082; $p < .05$). However, the realistic approach profile did not vary significantly across schools ($V(U_{0j})$ = .16; SE = .20; p = .41). Therefore, membership probability for teachers in the creative or emotional tension profile significantly differed across schools, but for those in the realistic profile it is unrelated to the school environment.

Research question 2: To what extent are principals' TL practices related to emergent LO profiles?

To examine the second research question, teachers' membership probability for the three LO profiles were regressed on their demographics of gender, age, and years at their current school, along with the school principal's TL practices (ISTE-A, 2009) and certain school demographics (i.e., school's number of students and educational stage). The realistic approach LO profile was treated as reference group (see Table 2).

The results indicated that older teachers had a higher probability of assignment to the creative tension profile compared to the realistic approach profile (OR = 1.03; 95% CI = 1.01–1.05; $p < .05$). Nevertheless, one must be cautious when interpreting this comparative difference because the membership probability for the creative tension profile went up only 3 percent for each one-unit increase in teacher age, after adjusting for the other prospective predictors in the model.

Table 2. Multilevel Predictors of the Learning Organization Profiles

	Realistic Approach (57.1%) (Reference Group)			
	Creative Tension (32.2%)		**Emotional Tension** (10.7%)	
Predictors	Odds Ratio (OR)	95% CI	Odds Ratio (OR)	95% CI
Teacher demographics				
Gender	1.13	[.68, 1.87]	1.08	[.66, 1.76]
Age	1.03*	[1.00, 1.05]	1.00	[.98, 1.03]
Years at current school	1.00	[.95, 1.05]	1.02	[.97, 1.07]
Principal's TL practices				
Visionary leadership	1.05	[.56, 1.97]	2.72	[.96, 7.82]
Digital-age learning culture	1.09	[.66, 1.81]	.88	[.40, 1.94]
Excellence in professional practice	.43	[.20, .94]	.60	[.22, 1.61]
Systemic improvement	2.08**	[1.31, 3.33]	1.50	[.80, 2.81]
Digital citizenship	1.09	[.50, 2.41]	.36	[.11, 1.18]

Educational Stage				
Mid. vs. Sec. (dummy)	.40*	[.22, .74]	.74	[.29, 1.89]
Mid. vs. Prim. (dummy)	.63	[.39, 1.03]	.49	[.22, 1.07]
No. of Teachers	1.00	[.98, 1.01]	1.00	[.98, 1.02]

Note. *p < .05; ** p < .01.

A teacher was twice as likely to be classified in the creative tension profile as opposed to the realistic approach profile, if he or she worked with a school principal who reported higher commitment to the "systemic improvement" set of TL practices (OR = 2.08; 95% CI = 1.31–3.33; p < .01). Statistically speaking, for each one-unit increase in a principal's "systemic improvement" set of TL practices, the odds of a teacher's membership in the creative tension LO culture increased by 208 percent, compared to his/her probability of being classified in the realistic approach profile. Therefore, a principal's TL practices related to the "systemic improvement" set of standards (ISTE-A, 2009) are found to be significant predictors of the creative tension profile in schools. Though not reported in Table 2, it is rather thought-provoking to note that, out of the five sets of ISTE-A (2009) standards, school principals paid the least attention to their "systematic improvement" related TL practices (Mean = 3.75; SD = .79).

Further, middle school teachers were found to be more likely clustered in the creative tension profile compared to the realistic profile (OR = .40; 95% CI = .22–.74; p < .05). Proportionately, the odds of being a teacher classified in the creative tension profile were 60 percent higher if the teacher worked at a middle school instead of a secondary school. Given that the educational stage variable with three options was coded as two dummy variables relative to one reference category, the middle school stage was chosen as the reference category and benchmarked against the primary school stage. However, we did not find any evidence for the middle school teachers over the primary school teachers in terms of their odds of being clustered into the creative tension profile (OR = .63; 95% CI = .39–1.03; p > .05).

Finally, the second column in Table 2 shows whether teacher and school level predictors would lead teachers to be clustered into the emotional tension profile, instead of the realistic approach profile. The comparison of these profiles did not yield a significant odds ratio for any predictor (p > .05).

DISCUSSION AND CONCLUSION

The aim of this study is twofold. The first goal is to reveal distinct profiles of LO culture based on teachers' professional learning orientations. The second is to determine to what extent a principal's TL

practices can be a predictor of those emerging profiles. Cluster analysis revealed three distinct profiles of LO culture where professional learning orientations are uniformly stratified at low, moderate, and high levels. The profile structures and levels depicted in the present study are almost identical to those obtained by Pang (2006). In our study, over half of the teachers (almost 57%) were clustered in the realistic approach profile where teachers' professional learning orientations were evenly dispersed at a moderate level. Likewise, Ning, Lee, and Lee (2015) found the largest profile (which covered almost 52% of the teachers in their study) was the moderately engaged profile, whose teachers showed an average level of endorsement for their professional learning orientations. Likewise, Law et al. (2011) concluded that the vast majority of teachers are involved in a traditional school culture that underestimates the importance of collaborative professional learning to a large extent. Also, Sheppard (2003) contended that a static culture has long been the dominant workplace culture in schools, which is fundamentally flawed with limited expertise and insufficient awareness about organizational learning among teachers.

The most obvious, and exciting, finding to emerge from this study is that the creative tension profile with the highest level of professional learning orientation is found to be predictable when school principals exert TL practices in alignment with the "systemic improvement" set of standards in the ISTE-A (2009) framework. This set of standards is composed of three TL practices: a) employing qualified teachers who have a passion for ICT adoption, b) promoting strategic partnerships with other educational organizations, and c) making data-driven assessments of teacher and student performance in ICT use. In schools whose principals carry out these TL practices to a greater extent, there is a higher level of teacher endorsement of LO culture.

These results are consistent with casual connections undertaken in previous studies. Fullan (2007) described effective school principals as being outward-looking and monitoring school improvements with benchmarks. Moreover, it is widely acknowledged that principals who seek strategic ties to other organizations tend to foster more sustainable LO culture in their schools (Aydin, Guclu, & Pisipia, 2015). Principals endowed with the ability of information acquisition are expected to endeavor to collect information on other organizations for establishing strategic partnerships, and to hire well-qualified teachers (Schecter & Atarchi, 2014). More precisely, Dexter (2008) argues that a principal's data-driven decision-making tendency serves as a powerful tool for leading ICT integration efforts. Vanderlinde, Dexter, and van Braak (2012) also attribute the effectiveness of ICT policies and leadership practices

to data-driven decision making and monitoring activities. By employing new teaching staff with a strong commitment to shared values such as ICT integration, principals can make a considerable contribution to the collaborative school culture (Leithwood et al., 1998). More directly linking the ISTE-A framework to LO culture, Maddin (2014) undergirds the importance of the systemic improvement set of TL standards in making a purposeful and systemic change in schools.

Despite accumulating evidence on the extension of the "systematic improvement" orientation to school culture, in this study we found that Turkish school principals demonstrated the least commitment to the systemic improvement standard, on average, compared to the other four sets of ISTE-A standards. Likewise, many past studies (e.g., Bülbül & Çuhadar, 2012; Görgülü, Küçükali, & Ada, 2013; Ünal, Uzun, & Karataş, 2015) concluded that Turkish school principals had the lowest average in their data-driven decision making, ICT-oriented employment policy and benchmarking activities.

School grade was another significant predictor of the creative tension profile in which middle school teachers (teaching grades 4–8) were more likely clustered. This finding is not completely surprising since past studies have demonstrated that middle school teachers have the opportunity to embrace some aspects of both primary and secondary school culture in that they experience the close-knit school culture of grades 4–6 but also professional specialization and isolation culture within different departmental areas in grades 6–8 (Pogodzinski, 2013; Scribner, Cockrell, Cockrell, & Valentine, 1999). Given the previous literature, we conclude that middle school teachers may be in a more advantageous position than teachers of other grades for accessing school-based collaborative learning opportunities due to their intimate collegial relationships such as seen in primary schools. Also, they may excel in their personal mastery and mental models orientations with much more ease, thanks to their expertise in teaching subject fields.

Finally, the data indicate that older teachers have a slightly higher tendency than their younger peers to endorse the creative tension LO culture in schools, compared to the realistic approach LO profile. Although these results concerning the connection between a teacher's age and perception of LO differ from the findings of some earlier studies (Mulford et al., 2004), they are still consistent with those of others (Celep, Konaklı, & Recepoğlu, 2011; Recepoğlu, 2013).

Another notable finding of our study is that teacher endorsement of the realistic approach profile is irrelevant to the school environment. Statistically speaking, the probability distribution of a teacher being

assigned to the realistic approach profile was equal across schools, that is, varying independently from the school context. Fritz (1989) makes sense of this situation in terms of individual differences in teachers' conflict toleration tendency, claiming that most people in educational organizations are prone to limit their aspirations to something reasonable/tolerable in their minds even if those limitations do not meet organizational expectations. They may act in a certain manner that accords with the notion of "Don't make waves/Don't rock the boat" because "aptitude is often substituted for vision in the school systems" (Fritz, 1989, p. 71). Under the effect of such personal sense-making and situational tolerance options, individual characteristics can have a greater influence than contextual factors on a teacher's professional learning perception (Imants, Wubbels, & Vermunt, 2013; Luttenberg, van Veen, & Imants, 2013). Thus, not surprisingly, the teachers were roughly equally grouped into the realistic approach profile, regardless of their school affiliation.

The results of this study provide empirical support for the idea that a school principal's "systemic improvement" set of TL practices are significantly associated with teachers' professional learning orientations and related LO culture in schools. These practices are composed of principals' data-driven assessment skills, outward-looking social relations, and inclination to recruit technology-oriented teachers for their schools. This conclusion can be framed on the basis of Senge's (1990) LO theory, wherein leadership practices are viewed as a source of change and seen to influence the pressure accompanying change that leads to structural conflicts. Therefore, TL practices are prone to produce similar structural conflicts that entice teachers into reacting to, generating, or tolerating the pressure that may arise from ICT integration. The current study shows that school principals can turn such structural conflicts into creative tension if they implement the "systemic improvement" set of TL practices in accordance with the ISTE-A (2009) framework.

Nonetheless, this study has some limitations. The main limitation concerns the generalizability of the research findings to other cultural contexts beyond Turkish schools. Even though multilevel analyses were conducted with an adequate sample size, the results obtained are representative for a single educational province in Turkey. National and international studies are needed, handling the same variables through multigroup LCA procedures in a variety of cultural contexts. In addition, although we herein kept certain teacher and school demographics methodologically under control, there may be many other covariates in play (e.g., ICT infrastructure, teachers' level of ICT use, existence of an ICT plan) that may add to the emergent LO profiles. Further, principals' TL practices were assessed using

only self-report measures. To overcome this hurdle, further studies can gauge TL practices through multiple sources (e.g., from the perspective of students, teachers, and regional authorities) and use a mixed research design based on both quantitative and qualitative data.

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CHAPTER 4

PROFESSIONAL SELF-EFFICACY INSTRUMENT FOR INFORMATION AND COMPUTER TECHNOLOGY COORDINATORS: VALIDITY AND RELIABILITY STUDY

Abstract

This study aims to develop a valid and reliable research instrument to measure information and communication technology (ICT) coordinators' professional self-efficacy based on the Turkish National Competency Framework for ICT Coordinators. Data collected from 190 pre-service ICT coordinators were analysed with respectively principal component analysis (PCA) and confirmatory factor analysis (CFA). PCA results revealed that the instrument's seven-component measurement structure accounts for 65.90% of total variance. CFA results produced an acceptable statistical support for model-data fit between the observed item scores and the seven-component structure (X^2/df= 1.98, RMSEA= .073, CFI= .86). The standardized regression weights between the latent and observed variables ranged from .57 to .89. Cronbach's alpha coefficient of the components ranged from .80 to .88. Besides, the item-total correlations varied between values of .53 and .79. Next, data collected from 67 pre-service ICT coordinators were used to confirm the time invariance of the instrument. As such, we developed a psychometrically sound Likert questionnaire constructed under seven dimensions with 33 items. At last, the developed instrument was employed to measure 53 in-service ICT coordinators' professional self-efficacy. Results showed that in-service ICT coordinators report the highest level of professional self-efficacy in the "safe and ethical ICT use" competence; while obtain the lowest score in the "multimedia applications" competence. The results of variance analysis indicate that female ICT coordinators report significantly higher professional self-efficacy in instructional design, hardware and software, measurement and evaluation, safe and ethical ICT use competency fields than their male counterparts.

INTRODUCTION

Recent years have witnessed rapid and extensive advances in information and communication technology (ICT). Depending on ongoing technological advancements and their reflections in educational technologies, teachers are expected to develop their professional competencies in using basic ICT skills, and further to integrate the use of ICT into their repertoire of teaching strategies. Not only external forces operating outside the school, such as national ICT policies, urge teachers to be more informed with up-to-date educational technologies, but also internal support of other educational stakeholders, such as students, ICT coordinators, school principals, promotes the use of ICT among teachers for instructional purposes (De Smet, et al. 2012; Tondeur, et al. 2008).

As for providing internal ICT support, a great part of the responsibility was traditionally placed on the shoulders of ICT coordinators (Strudler & Hearington, 2008). Early research documented that the most predominant roles assigned to ICT coordinators were student mentorship, being role models for other teachers, and giving technical assistance (Hancock, 1990). Coupled with providing technical support and supporting student learning (Somekh et al., 2002; Devolder et al.,2010), however, more recent research has expanded the scope of ICT coordinators' role definition to making ICT policy planning (Marcovitz, 2000; Vanderlinde, van Braak, & Hermans, 2009), engagement with monetary planning for ICT uptake (Lai & Pratt, 2004), providing professional trainings as to effective ICT use (Somekh et al. 2002), as well as giving pedagogical support to other teachers as "educationalists" (Devolder et al., 2010). Despite such a wide range of roles described, the most critical question remained the same: how many of these roles could be fulfilled in practice? (Kennewel, Parkinson & Tanner, 2000).

As ICT coordinators are responsible for guiding other teachers as change agents (Strudler, 1995), facilitator of change (Vanderlinde et al., 2009), and even leaders (Lai & Pratt, 2004); they are primarily required to upgrade their own level of professional competencies (Araiz, 2018). For doing so, a sense of self-efficacy is one of the major elements that empower ICT coordinators to actualise their personal potentials, and also lead others towards technological-pedagogical change (Avidov-Ungar & Hanin-Itzak, 2017; Avidov-Ungar & Nagar, 2015). Bandura (1986) defines self-efficacy as individual judgements about one's own capabilities to organise himself/herself and get into action in alignment with desired goals. More specifically, Compeau and Higgins (1995) define ICT self-efficacy as one's judgement on his/her own potential to use computer. Hatlevik and Hatlevik (2018) distinguish between general ICT self-efficacy and self-efficacy in using ICT for instructional purposes. This interpretation

assumes a teacher's self-perception of adequate competence once to use it for instructional practices. When it comes to measuring ICT coordinators' self-efficacy, for avoiding a tautology in the definition, we attend to the umbrella term "professional self-efficacy". Because the mastery of ICT use and the use of ICT for instructional practices is imminent in an ICT coordinator's professional competencies. In the following section, we provide a brief overview of the developed international and national competency frameworks for ICT coordinators.

Professional Competency Frameworks for ICT Coordinators

To clarify and categorise the professional competencies and their performance indicators required by ICT coordinators, various frameworks were developed by international organisations and national educational authorities. For instance, in many states of the USA , ICT coordinators are required to meet the requirements of the International Society for Technology in Education (ISTE-C, 2011). This framework provides a wealth of information presented in a compact form with six standards, such as 1) visionary leadership (i.e. inspiring and participating a shared vision), 2) teaching, learning, and assessment (i.e. assisting teachers in using ICT and evaluating the results thereof), 3) digital-age learning environments (i.e. creating and sustaining ICT-supported learning environments), 4) professional development (i.e. conducting needs assessments of teachers and developing ICT-related trainings for them), 5) digital citizenship (i.e. role-modelling and promoting ethical, safe and equal access to ICT), and 6) content knowledge and professional growth (i.e. personal mastery of ICT-enriched content development, pedagogical skills, and leadership practices).

The "ICT Competency Framework for Teacher" was developed by UNESCO (2011) with a modular structure in which ICT coordinators could follow three modules in accordance with their role rationale. These modules are 1) understanding ICT in education (i.e. having a policy awareness linking national policies to the needs of classroom environment), curriculum and assessment (i.e. having an excellent knowledge of standards as to curriculum, assessment, ICT integration), pedagogy (i.e. having the knowledge of when, where and how to use ICT appropriate for classroom practices).

Besides these well-known international organisations, some national and regional authorities endeavoured to define various professional competency frameworks for ICT coordinators. In Australia, for instance, most of regional authorities published comprehensive professional competency frameworks, involving some performance indicators for ICT coordinators. To give an example from Queensland district, the Queensland College of Teachers (2011) published the "Australian Professional

Standards for Teachers" in order to define ICT-related professional competencies with three performance indicators, such as 1) Using ICT to expand curriculum, developing ICT-related content, modelling and leading colleagues in the effective use of ICT 2) selecting and using the most appropriate ICT sources, c) using ICT safely, responsibly and ethically. Yet, in the Northern region of Australia, ICT-related professional competencies were described by Department of Education and Training (2004) under two "critical elements": 1) selecting and using instructional resources and ICT (with 6 performance indicators), and 2) integrating use of ICT to enhance student learning (with 4 performance indicators).

In Turkey ICT coordinators were nominated as "the leader of change" by the Turkish Ministry of National Education (TMONE, 1993) nearly three decades ago. However, after many years, professional competencies required of those "leaders of change" were described in the "National Competency Framework for ICT Coordinators (TMONE, 2008). In this framework, ICT coordinators' performance indicators were categorised into seven competence fields: 1) mastery of instructional design, 2) using ICT-related concepts properly, 3) measurement and evaluation tools, 4) hardware and software equipments, 5) multimedia applications, 6) instructional software, and 7) safe and ethical ICT use fields.

Based on the above seven competence fields and their performance indicators, we set out to construct the first Turkish research instrument in order to measure Turkish ICT coordinators' professional self-efficacy levels. Using this instrument and a separate set of data with gender and age demographic information, we also carry out descriptive, variance and correlational analyses of 53 in-service ICT coordinators' professional self-efficacy levels. Therefore, the research objective underlying this study is to develop a psychometrically sound research instrument that is able to assess Turkish ICT coordinators' professional self-efficacy in accordance with the performance indicators in the "National Competency Framework for ICT Coordinators" (TMONE, 2008). In addition, we aim to undertake a plot study of this instrument with in-service ICT coordinators.

METHODOLOGY

Data Collection

For developing and validating a research instrument, preliminary data were collected from 190 pre-service ICT coordinators who were studying at Computer and Information Technologies Education (CITE) departments in three Turkish state universities. Next, additional data collected from 67 pre-service ICT coordinators at 2 time points with 2-week interval were utilized to verify the test-retest reliability evaluation of the instrument. At last, we administered the final form of the developed research

instrument to 53 in-service ICT coordinators, of which 60.40% (32 respondents) were male and 39.60% were female. ICT coordinators' age varied from 23 to 40 years old, with an average age of 32 years old. Out of 190 pre-service ICT coordinators, 60% (114 respondents) were males and 40% (76 respondents) were females. Pre-service ICT coordinators' age information was not asked for.

Sample Size

As a general rule of thumb to determine adequate sample size, there should be at least 5 respondents per item for reliability and validity analyses procedures (Gorsuch 1983; Streiner 1994). Sample size of the present study (i.e. 190 respondents) may be regarded acceptable according to 5:1 respondent ratio per item (i.e. 33-items).

Additionally, Ullman (2001) indicated that the general guidelines for sample size might be misleading without taking into consideration analysis results obtained from datasets. For instance, Worthington and Whitetaker (2006) suggested that sample sizes of 150-200 is likely to be adequate with datasets including communalities of .50 or greater. For this study, all communalities of items produced greater values than .50, ranging from .50 to.84. Thus, this study's sample size may be considered large enough to provide empirical evidence to reliability and validity analyses.

Draft Instrument

Initially, a 53-item draft instrument was produced from performance indicators of the official competency framework. Next, in order to gather expert opinions, an expert panel was established with the participation of four scholars with two rounds of correspondence via email. All scholars were faculty in the department of CITE. They reviewed the 53-item first draft instrument for its face and content validity. Based on their expert opinions, appropriate revisions and modifications were made as presented in Table 1. The two items criticised for being ideological by one panel members were excluded from the draft instrument. In addition, six more items were discarded for failing to pass the criterion of majority agreement on item applicability among the panel members.

Table 1. Sample Expert Opinions

Items before review	*Expert-proposal for items*	*Revised items*
I can develop instructional materials by using MS Office programs. (Draft Item)	"Using only office programs are not adequate and satisfactory for assessing ICT coordinators' skills for developing instructional material. So item should be improved by stressing software types." (Reviewer 1) "In addition to MS Office programs, this item is to be revised in a way that it covers other similar software applications." (Reviewer 3)	I can develop instructional materials by using *word processor* software applications (item-24). I can develop instructional materials by using *spreadsheet* software applications (item-25). I can develop instructional materials by using *presentation* software applications (item-26) I can develop instructional materials by using database software applications (item-27) I can develop instructional materials by using *desktop publishing* software applications (item-28)
I can stimulate students to make proper slide shows to be demonstrated in national celebrations at school. (Draft Item) I can integrate "Ataturkcu (Kemalist)" values into ICT curriculum (Draft Item)	"Although the official competency framework contains some abstract national and political content, obviously there is no relationship between national-ideological topics and ICT coordinators' professional competencies. So these must be extracted from the instrument." (Reviewer 4)	Both items were extracted from the scale.
I can prepare web-based instructional materials. (Draft Item)	"The item should emphasize multi-media content of web-based materials and yet it defines no qualification about web-based materials." (Reviwer 2)	I can prepare web-based instructional materials in line with *the principles of multi-media* (Item-9).

Data Analysis

The dataset with 190 respondents was analysed by respectively principal component analysis (PCA) and confirmatory factor analysis (CFA). Instead of principal factor analysis (PFA), we employed PCA in order to test construct validity of the draft instrument. Although the choice between PFA and PCA is a long-standing debate in the literature (Field, 2009), the reasoning underlying a researcher's choice should follow a clear rationale about what he/she would like to do. To put simply, DeCoster (1998)

suggests that researchers should opt for PFA if the aim of their research is to identify the nature of underlying latent factors through observable measures, and if empirically required, reduce the number of these latent factors. On the other hand, researchers should opt for PCA if they would like to reduce a large number of variables (not factors), while still retaining as much of the original variance as possible (Conway & Huffcutt, 2003). Note that in our study performance indicators by which we produced our draft items are not based on theoretically constructed latent factors; instead, they are a large set of performance indicators thought to be related to professional competencies required of ICT coordinators by TMONE (2008). Following this basic rationale, in this study we used PCA in order to test construct validity of the proposed draft instrument.

The measurement structure resulted from PCA was examined through CFA afterwards. In order to evaluate the theoretical model-observed data fit, X^2/df (chi-square/degree of freedom), comparative fit index (CFI) and root mean square error of approximation (RMSEA) indices were preferred because those are the most frequently reported ones, and what is more, CFI and X2/df ratios are relatively immune to possible misleading effects stemming from sample size (Ullman, 2007). In addition to these fit indices, convergent and discriminant validity of the measurement model was examined through computing composite reliability (CR), average variance extracted (AVE), maximum shared squared variance (MSV) and average shared squared variance (ASV) values. Croanbach's alpha coefficients were computed to validate internal consistency of the research instrument. Besides, item-total correlations were used to check internal consistency of the instrument. At last, test-retest procedure was performed to confirm the instrument's reliability measured over time. The t-test was used to determine whether there was a significant difference in mean professional self-efficacy levels between male and female ICT coordinators. The Pearson's correlation coefficient was computed to determine whether there is a relationship between age and professional self-efficacy levels of ICT coordinators.

RESULTS

Of the 45 items, 11 ones were eliminated from PCA due to either poor loadings lower than .50 or double-loadings across more than one component. As such, PCA yielded seven principal components with the minimum eigenvalue of 1. Among the remained items, the lowest loading was calculated to be .596, whereas the highest one was .842. The seven-component measurement construct, when all the percentages are summed up, accounted for 65.90% of the overall variance (see Appendix).

Since the researchers' measurement survey relied on self-reported questionnaire, it was important to ascertain to which extent the common method bias (CMB) exists. Correspondingly, Harman's single factor test was conducted to statistically explore the prospective effect size of CMB. In brief, Harman's single factor test aims to determine how much variance might be ascribed to a forced single-dimension. In cases this common factor explains more than 50% of the total variance, there could be an issue with CMB (Podsakoff et al. 2003). The test results showed that, when all 34 items were loaded into one general factor, the relevant single-factor represented only 29.60% of the total variance. Therefore it was evidenced that the developed measurement model was immune to common method bias.

For the next step, data were investigated by a confirmative follow-up study to determine whether the measurement structure identified by PCA is consistent with the collected data or not. To begin with, the measurement model was set on the seven-component solution in which each component was depicted as an unobserved (latent) variable; and hence, the estimated model with 34 items get into analysis. After removing Item-19 from the model due to its high standardised residuals of 3.212, the second model (33-item) produced acceptable goodness-of-fit scores. Besides, modification indices for covariances suggested a linkage between the error terms of Item-15 and Item-14, Item-16 and Item-17, Item-39 and Item 40. By this means, the last modified model revealed slightly better goodness-of-fit scores (x^2/df= 1.98; RMSEA= .073, CFI= .86).

The literature review undertaken to evaluate the evidence for the model-data fit shows that when the ratio of x^2 to degree of freedom is less than 5, it displays an acceptable model-data fit (Gillaspy 1996; Schumacker & Lomax 2004). As the estimated ratio remained between values of 2 and 3, it can be interpreted as an indicator for an acceptable model-data fit (Ullman 2001). CFI index yields a fit index that lies just in the 0 to 1 range. CFI value of 0.90 and above is considered sufficient for an acceptable fit. RMSEA value of 0.80 and less is taken as evidence of acceptable fit (Sumer 2000; Albright & Park 2009). Based upon these criteria, the measurement model produced x^2/df ratio of 1.99 indicating a perfect model-data fit ($p < .001$). Additionally, the RMSEA value of .073 is less than threshold value of .080. That is, the current model has a reasonable fit with the collected data. However, CFI value of .86, a little less than .90, revealed the our model slightly falls short of the conventional cut-off point, but just a little below that. Insofar as such a small amount of deviation (that is, .04) from the threshold came into question, it was not considered as a significant violation of model-data agreement. Therefore, on the whole, the construct validity of the seven-component measurement model with 33 items appears to be

reasonably adequate. The Figure 1 below illustrates the measurement model and the relevant standardized estimates for further examination.

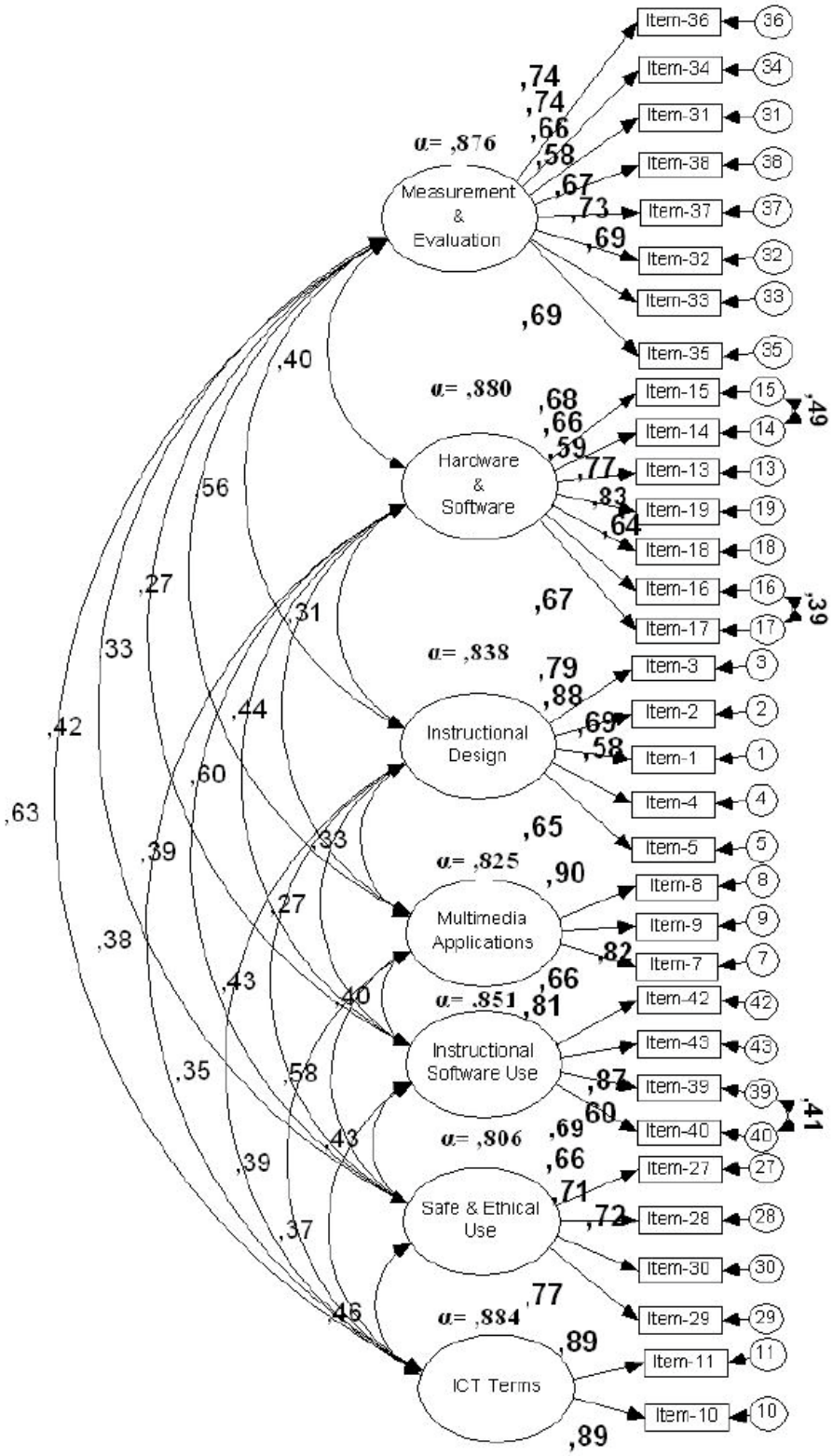

Figure 1. Confirmatory factor analysis and standardized estimates

Component loadings (standardized regression weights) across the seven components ranged from .58 to .90. The examination of these loadings reveals that all 33 items have significant loadings on the construct and none of them exceeds the cut-off value of ≥50, which is a recommended point especially for measurement models including newly developed items (Hulland 1999). Internal consistency reliability of the seven components ranged from Cronbach's alpha values of .80 to .88. Another point to check is that the estimated correlations between components did not exceed the absolute point of .90 (Kline 2011). The convergent and discriminant validity of the model were examined by calculating CR, AVE, MSV and ASV values by using the regression weights and correlation coefficients. The results are presented below.

Table 2. The Convergent and Discriminant Validity of the Measurement Model

Components	*CR*	*AVE*	*MSV*	*ASV*
Measurement and Evaluation	.87	.52	.39	.20
Instructional design	.84	.51	.31	.15
Hardware and Software	.87	.52	.36	.19
Instructional material development	.83	.56	.36	.17
Safe and Ethical use	.80	.51	.34	.20
Multimedia applications	.84	.64	.34	.17
Use of ICT terms	.89	.79	.39	.19

The above pattern of results revealed that the mentioned values were evidence of the measurement model's validity in question. That is, CR exceeds both AVE and value of .7 for each case. Also it is seen that AVE exceeds MSV and ASV. Additionally, AVE value is greater than the recommended cut-off point of .5 (Hair et al. 2010). Therefore, the measurement model's both convergent and discriminant validity was evidenced by these computations.

The corrected item-total correlations ranged from .533 to .792. To put differently, the results to emerge from this study produced good correlation coefficients for the item discrimination of the instrument. Each item's contribution to respective component reveals that items make a positive contribution to the overall reliability of the instrument. Additionally, another item discrimination analysis was carried out by

comparing the total scores of the lower and upper 27 % groups. Results reveal that the mean difference between upper and lower groups proves to be significant (p<.001).

As for test-retest procedure, the research instrument was administered to 67 pre-service ICT coordinators with two weeks interval. Test-retest reliability was used to confirm the developed instrument's time invariance. Eventually there occurred a relatively strong relationship between test and retest scores. The obtained correlation coefficients ranged from .73 to .92. These results confirm the reliability of the instrument in terms of time invariance.

At last, the developed research instrument was administered to 53 in-service ICT coordinators. The results of variance analysis (t-test) revealed that female ICT coordinators had higher professional self-efficacy levels in instructional design ($t_{(51)}$=-3.32, p=<.01), hardware and software mastery ($t_{(51)}$= -2.62, p<.01), measurement and evaluation ($t_{(51)}$=-3.16, p<.01), safe and ethical ICT use ($t_{(51)}$= -2.93, p<.01) competency fields than their male counterparts. However, we did not find a significant correlation between age and professional self-efficacy levels of ICT coordinators.

DISCUSSION AND CONCLUSION

Before setting out to develop a psychometrically sound research instrument for measuring ICT coordinators' professional self-efficacy levels, we reviewed a number of national and institutional frameworks, their standard definitions, performance indicators in regard to ICT coordinators' professional competencies. Based on our reviews, we can assert that central to all these competency frameworks is to build ICT coordinators' professional capacity of collaborative working, vision building, problem solving and being creative learners by means of ICT (UNESCO, 2011). As Vanderlinde, van Braak and Dexter (2012) revealed that the development of teachers' ICT skills are related to school-based ICT policy plans as blueprints, and also the implementation of these plans in practice. Overall, governmental ICT policy plans correspond to the capacity building need of countries to develop their national human resources so that national ICT policies embark on updating their present teaching workforce by developing their up-to-date content, pedagogy and technology related professional competencies (Danner & Pessu 2013).

In this respect, the results of this study indicate that Turkish National Competency Framework is a useful document on professional competency fields and performance indicators. Based on this document, we constructed a research instrument that assesses ICT coordinators' professional self-efficacy in seven competency fields. We can classify these competency fields into content knowledge (i.e. use of ICT

terms, material development), pedagogical proficiency (i.e instructional design, measurement and evaluation) and technology using ability (i.e. hardware and software, multi-media applications, safe and ethical use).

Moreover, ICT coordinators are needed to be change agents in leading other teachers to use ICT in effective ways (Lai & Pratt 2004). However, our results show that "National Competency Framework for ICT Coordinators" does not concern about the technology leadership role of ICT coordinators at all. Indeed, UNESCO (2011) cast a leading role to ICT coordinators in providing follow-up support to colleagues and creating a shared-vision in school. In this sense, Turkish competency framework appeared to be deficient in embracing technology leadership as one component of ICT coordinators' professional competencies.

As for the results to emerge from the survey of in-service ICT coordinators, we reveal that gender differences are related to ICT coordinators' professional self-efficacy levels. Previous studies give unequivocal results in relation to the importance of gender differences in ICT self-efficacy. On the one hand, there are many studies which could not find any gender difference associated with ICT self-efficacy (e.g. Pamuk & Peker, Scherer & Siddiq, 2015; Teo, 2008). On the other hand, the findings of some studies (e.g. Dundell & Haag, 2002; Gudmundsdottir & Hatlevik, 2017; Sieverding & Koch, 2009) concluded that males report higher levels of ICT self-efficacy compared with females. However, as far as we are concerned, this result had not previously been described in favour of females before our study. Given the dearth of previous studies supporting our finding, it is difficult to explain this result. There is a need for further studies with more focus on possible moderators of gender demographics and ICT coordinators' professional self-efficacy.

The current study aimed to develop a research instrument that measures professional self-efficacy levels of ICT coordinators, based on the National Competency Framework for ICT Coordinators (TMONE, 2008). Based upon the relevant competency framework, seven-component structure with 33 items was evidenced by PCA and it explained 65.90% of the overall variance with .60 of minimum loading. At first phase, Harman's single factor analysis was performed to verify the common method bias (CMB) and single-factor unrotated solution accounted for only 30% of the overall variance indicating the absence of the CMB issue. The follow-up CFA evidenced the seven-component construct with acceptable model-data fit index with one excluded item. As a conclusion, the present research provided a sound psychometric property for the developed research instrument.

Moreover, the convergent and discriminant validity analyses supported the absence of CMB through CFA estimates. Besides, the developed measurement model produced robust internal consistency results so that all Cronbach's Alpha coefficients were greater than .80. Over two week period, test-retest correlations evidenced strong time invariance in reliability. At last, emerging principal components were named based on the national competency framework as measurement and evaluation, hardware and software, instructional design, multi-media applications, safe and ethical use, instructional material development, and use of ICT terms.

This study adds to the literature in several respects. First, the developed research instrument can be used by TMONE in performance management system because it is completely based upon the official national competency framework developed by TMONE. Second, however, the present research disclose a shortcoming of the present national competency framework in combining technology leadership competencies with other competencies. Future research is needed to investigate the extent to which ICT coordinators may contribute to building a shared vision on ICT integration by improving their professional-self efficacy levels and technology leadership competencies in leading other teachers towards this vision.

Given the overall psychometric properties of the "Professional Self-efficacy Instrument for ICT Coordinators" (PSI4ICT), we suggest that this instrument is appropriate to assess self-perception of ICT coordinators on their own professional competencies. Nevertheless, there are some limitations of the present study. When assessing their own professional competencies, there is an inclination for respondents to underrate or overrate themselves on self-report instruments. Besides, we note that the scores obtained from the instrument do not add up to professional competencies, but self-efficacy about these competencies. The psychometrical measurement was conducted with pre-service ICT coordinators. Thus, there is a need for further research to be conducted with data from in-service ICT coordinators.

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Appendix

Measurement Items and Component Loadings

Items	*Components*							*Eigenvalue*	*Explained variance*
	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*		
I.15) I can *solve* confronted software/equipment problems.	**.828**	.070	.019	.067	.057	.012	-.024	4.589	13.50%
I.14) I can *detect* software/equipment problems that can be faced.	**.824**	.115	.161	.035	.087	.015	-.060		
I.13) I can use different versions of available operating systems.	**.709**	.136	-.072	.172	.054	-.096	.070		
I.16) I can carry out operations using file extensions programs.	**.700**	.101	-.004	.082	.096	.171	.146		
I.18) I can operate a computer and its environment units on a network.	**.683**	.060	.191	.311	-.043	.268	-.019		
I.19) I can use software required for network administration.	**.631**	.101	.061	.278	-.007	.316	.063		
I.12) I can set up a computer system to the purpose.	**.614**	.059	.130	-.024	.439	.064	.252		
I.17) I can prepare activities for learners' sharing files.	**.609**	.234	.127	.155	.156	.213	.147		
I.36) I can rearrange ICT learning environment in direction of evaluation results.	.055	**.736**	.255	.064	.132	.145	.027	4.487	13.19%
I.34) I can give feedback to learners about ICT objectives, methods, results of measurement and evaluation.	.188	**.731**	.048	.024	.133	.097	.208		

I.31) I can determine learners' ICT levels through measurement and evaluation process.	.032	**.715**	.066	.010	.065	-.140	.223		
I.35) I can test the validity and reliability of a measurement instrument to evaluate learner products.	.019	**.691**	.202	.072	.082	.116	.097		
I.37) I can record learners' measurement and evaluation results in computer environment.	.199	**.677**	.231	.214	.067	.153	-.167		
I.38) I can give feedback to learners about their academic achievement via internet.	.167	**.642**	.031	.321	.022	.067	-.073		
I.32) I can use the evaluation tools peculiar to ICT.	.155	**.626**	.343	.017	.006	-.046	.290		
I.33) I can evaluate both learner's ICT learning processes and products appropriate to curriculum.	.126	**.596**	.270	.069	.132	-.119	.263		
I.02) I can plan the instructional process taking *learners' level of progress* into consideration.	.080	.159	**.822**	.175	.180	.095	.036		
I.3) I can plan the instructional process taking *learners' learning styles* into consideration.	.019	.138	**.815**	.150	.087	.067	-.054		
I.5) I can plan the instructional process in a way that the learner can reflect it on his daily life.	.102	.278	**.694**	.069	-.027	.084	.000	3.395	9.99%
I.1) I can plan the instructional process taking *learners' needs* into consideration	.158	.233	**.683**	-.025	.198	.013	.072		
I.4) I can plan the instructional process through linking it with	-.008	.150	**.621**	-.055	.114	.135	.204		

different fields unlike ICT.									
I.40) I can inform learners about the ethical dimension of technology use.	.131	.104	.261	**.806**	.044	-.007	.098		
I.42) I can recognize the threats from the internet.	.252	.096	-.029	**.772**	.142	.093	.048	3.035	8.92%
I.43) I can take measure against threats from the internet.	.279	.029	-.027	**.760**	.163	.205	.132		
I.39) I can raise learners' awareness of health problems originating from technology.	.073	.250	.093	**.755**	.083	.064	.008		
I.27) I can develop instructional materials by using database software applications	-.028	.117	.218	.152	**.762**	.033	.000	2.776	8.17%
I.28) I can develop instructional materials by using desktop publishing software applications	.104	.098	.189	.098	**.730**	.148	.142		
I.29). I can enrich learning activities using the animation programs.	.126	.266	.076	.180	**.711**	.222	-.015		
I.30) I can design web-supported teaching materials using the codes particular to a programming language.	.257	.020	.006	.002	**.707**	.285	.129		
I.8) I can *develop* web-based distance education materials.	.113	.024	.056	.145	.234	**.842**	.114		
I.9) I can *prepare* web-based instructional materials in line with the principles of multi-media.	.151	.225	.153	.005	.219	**.799**	.105	2.415	7.10%
I.7) I can use specific educational software best suited to my teaching objectives.	.277	-.065	.199	.201	.204	**.636**	.018		
I.11) I can prepare learning activities to	.094	.387	.140	.161	.089	.168	**.770**	1.696	4.99%

encourage learners using ICT terms properly.							
I.10) I can easily find Turkish equivalents of the ICT terms in foreign language.	.224	.320	.090	.150	.213	.141	**.744**

CHAPTER 5

WHO CHOOSES WHOM FOR PROFESSIONAL INTERACTION? A SOCIOMETRIC INQUIRY INTO THE RELATEDNESS OF TECHNOLOGICAL AND PEDAGOGICAL ADVICE-SEEKING RELATIONSHIPS AMONG TEACHERS

Abstract

Social capital is manifested through human interactions mediated by the prevailing cultural norms and values within a society. In school settings, advice-seeking relationships (ASRs) are the most common form of these interactions between teachers. More particularly, ASRs on technological and pedagogical issues are two substantive and interrelated issues germane to teachers' professional interactions. When engaging ASRs, teachers tend to interact with subject-specific expert colleagues, such as technology-savvy teachers and senior teachers with more pedagogical experience. However, professional interactions are also subject to the complexity of individual, relational and organisational factors apart from the expertise. In this two-fold study, we investigate such multilevel antecedents and the interrelatedness of technological and pedagogical ASRs within teacher communities. Social network analysis (SNA) was employed to capture and analyse teachers' related ASRs. Our study shows that school contexts that support a positive school culture, i.e. learning organisation (LO) culture, improve professional interactions between teachers on pedagogical issues in particular. As the LO culture is in place to support teachers professional learning, they are more likely to be equally sought out for both technological and pedagogical advice as hybrid expert teachers. In these schools with high level LO culture, we found that the more teachers provide pedagogical advice to colleagues, the less they are sought out for technological advice. However, the more they provide technological advice, the more they are sought out for pedagogical advice by colleagues, regardless of school's LO culture level.

INTRODUCTION

In the era of information society, student learning has increasingly been digitised by information and communication technologies (ICT). Accordingly, the teaching profession has been subject to a digital transformation in that technological and pedagogical knowledge are specifically required for teachers to be equipped with 21st century teaching skills (Aydın & Zhu, 2018; Jaipal & Figg, 2010; Li & Choi, 2014). To ensure that such professional requirements are met, growing scholarly attention has been directed to on-the-job professional interactions primarily situated in the school context (Parise & Spillane, 2010). These interactions are mostly governed by self-initiated, spontaneous and voluntary collaboration within teacher communities, unlike those guided by formally structured, compulsory, and short-term training programmes. By the flow of professional knowledge from relatively more knowledgeable teachers to others, teacher collaboration may serve as a natural channel for individual teacher learning as well as organisational learning throughout the school (Hargreaves, 2001).

Advice-Seeking Relationships

Advice-seeking relationships (ASRs) embody the most common type of professional interaction within teacher communities (Little, 1990). While choosing with whom to engage in ASRs, teachers are expected to contact expert colleagues, such as technology-savvy teachers for ICT-related problems and senior teachers for pedagogical issues. Technology-savvy teachers refer to expert colleagues who are more preferred as informal leaders than others to be sought out for professional advice about educational technologies (Kelly, 2015). In other cases, some teachers may come to the fore with their *hybrid expertise* as much as they can incorporate both technological and pedagogical expertise into their professional interactions (Ryymin, Palonen & Hakkarainen, 2008). However, for the most part, a teacher's actual expertise may not be directly observable to colleagues insofar as instructional practices usually remain behind closed classroom doors (Wilhelm, Chen, Smith & Frank, 2016). Another drawback to consider is that ASRs could somehow be misconceived as an inadequacy of advice-seekers (Borgatti & Cross, 2003). Thus, teachers may avoid asking for expert opinion because of its psychological and social costs imposed on advice-seeker parties in particular. In order to release such burdens arising from ambiguity and psychosocial costs, teachers who share similar demographic characteristics (e.g. gender, age, status) prefer to contact each other, which is known as the homophily effect (Borgatti & Ofem, 2010; McPherson, Smith-Lovin & Cook, 2001). Overall, teacher expertise can be considered as individual, relational and context-dependent property based on perceived differences between people exchanging information (Edwards, 2005).

Based on the above considerations, ASRs are sensitive to certain individual, relational and organisational antecedents. Frank and Zhao (2005) classify those into micro, meso and macro-level factors. Micro-level factors involve teacher's individual characteristics, such as gender, age, experience, grade-level or subject-field taught. Findings of Moolenaar, Daly, Sleegers and Karsten (2014a), for example, revealed that male teachers were more sought out for ASRs on work-related advice exchanges, while female teachers were mainly seekers of advice. In a similar way, Bridwell-Mitchell and Lant (2014) concluded that female school principals are more eager than male counterparts to solicit advice from colleagues. Furthermore, it is found that older and more experienced teachers are found to participate in ASRs to a lesser extent than their younger and less experienced colleagues (Moolenaar, 2010). Moreover, Spillane (2005) showed that teachers' subject fields can make a difference in ASRs, partly irrespective of what formal positions they hold in the school structure.

From a more relational aspect, not only individual characteristics of advice-givers but also those of the advice-seekers are relevant to ASRs (Frank, Kim & Belman, 2010). Thus, certain common characteristics of both parties might have a share in the emergence of ASRs (Frank & Zhao, 2005). In order to control such two-sided nature of social relationships, (dis)similarities of individual characteristics should be taken into account as meso-level factors. By this means, meso-level factors allow us to consider local regularities in interpersonal relations, such as the homophily effect of shared personal attributes. A number of studies confirmed that teachers are more likely to seek advice from colleagues of the same gender, age, experience, grade-level and subject-field (Coburn, Choi & Mata, 2010; Daly, Moolenaar, Bolivar & Burke, 2010.; Moolenaar, 2010; Penuel, Riel et al. 2010).

Depending on the organisational and cultural context, ASRs may be responsive to certain *macro-level factors*, such as schoolwide shared values regarding professional learning (Coburn, 2001), trust (Bryk & Schneider, 2002), learning organisation (LO) culture (Finnigan & Daly, 2012), or innovative school climate (Moleenaar et al., 2014b). As such, an interplay of micro, meso and macro level factors shape ASRs in teacher communities to a large extent.

To better understand how professional interactions are formed between colleagues, we trace the flow of technological and pedagogical advice-seeking relationships (ASRs). In doing so, several individual, relational and organisational factors are examined for their influence on ASRs. Consequently, this paper seeks to address how structural network effects are associated with the relatedness of concurrent technological and pedagogical ASRs.

In framing our theoretical viewpoint and methodological investigation of ASRs, we draw on three relevant theories: social capital theory, learning organisation theory and social network theory. Through the sociological lens of these theories, we aim to offer a robust theoretical and analytical insight into ASRs.

Social Capital Theory

Social capital acts as an umbrella term that defines socially constructed resources that are available to individuals as a result of their involvement in social networks (Adler & Kwon, 2002). The manifestation of social capital depends on the presence of social relationships by which individuals, groups or organisations can access, borrow or leverage valuable resources, e.g. information, knowledge, or innovation (Daly, 2010). According to this theory, social embeddedness of an actor in diverse relational structures through, for instance, trust, friendship or work-related relationships has the potential to produce economic, cultural and social capital for oneself and the affiliated social networks as a whole (Bourdieu, 1986). One of the assumptions of social capital theory is that structural network features can support or restrict communication within and between communities (i.e. structural social capital). Moreover, they are associated with common cognitive values held by community members (i.e. cognitive social capital), such as shared vision and collective working routines (Lin, 2009; Nahapiet & Ghoshal, 1998). When ASRs tap into professional relationships among teachers, such collective values and working routines pave the way for a shared school culture that regulates teacher collaboration throughout schools (Lieberman & Miller, 2008).

Learning Organisation Theory

A “learning organisation” (LO) involves a group of organisational members who follow common aims with a collective commitment to a shared vision, and developing their personal capacities around this vision on a regular basis (Leithwood, Aitken, & Jantzi, 2001). Thus, the LO theory offers a holistic understanding of the aforementioned cognitive social capital, underlining the importance of shared school vision, collective values and working routines. Senge and colleagues (2000) identified five cultural characteristics of LOs: teachers’ capacity of generative dialog with other colleagues (i.e., team learning), collective aspiration for school values (i.e., shared vision), critical inquiry about school system (i.e., systems thinking), professional growth (i.e., personal mastery), and self-reflection (i.e., mental models). According to LO theory, a combination of all these five LO characteristics refers to LO culture.

Accumulating evidence from the education literature suggests that a supportive professional learning culture may provide teachers with powerful tools for learning from each other. For example, Finnigan

and Daly (2012) advocate that a positive school culture that promotes teachers to share ideas and practice through social networks is inevitably necessary for school improvement. Dexter and Anderson (2002) underscore the importance of LO culture for the emergence of community-centred and strong communication patterns that facilitate ICT-related advice exchanges among teachers. More specifically, Dexter (2008) points to the importance of team learning, shared vision and systems thinking so that teachers' learning needs regarding pedagogical use of ICT could be met. Likewise, Frank (2009) concluded that a teacher's self-identification with the school collective serves as a moderator for the social capital accumulation in teacher communities. This supports teacher collaboration through ASRs. Furthermore, the development of LO culture may encourage relatively expert teachers to establish ASRs with their comparatively less expert peers, and thus, to continue to learn out of their expertise domain (Farley-Ripple & Buttram, 2013).

In spite of the growing body of research on the relevance of LO culture to ASRs, little attention has been paid to the extent to which technological and pedagogical ASRs might be interrelated, and whether this relatedness differs in schools with high and low level LO culture. Such an original research interest entails a state-of-the-art theoretical and analytical approach of the social network theory that shifts the focus from individuals, groups and organisations to relationships within them as basic units of analysis.

Social Network Theory

What makes social network theory distinctive is its reflections on the fundamental concept of the network. A network is composed of a set of network actors, along with the ties that connect network actors by virtue of their existing relationships (Wasserman & Faust, 1994). Out of five types of relationships (i.e. similarities, social relations, mental relations, interactions, flows), ASRs are of the type "interactions" that can be conceptualized as discrete events repeating in a period of time (Borgatti & Ofem, 2010). The structure of interactions is identifiable by stable interaction patterns (Daly et al., 2010). In particular, social network theory fundamentally assumes that particular patterns of local interactions (e.g. reciprocity) may bring about structural effects on the overall network configuration, when they appear repeatedly within a given network structure. Social relationships are not merely composed of local ties between specific people, but rather a set of ties nested in an entire population (Sailer, 1978). In order to articulate how these structural effects depicted by local interaction patterns are relevant to the construction of overall network configurations, three key concepts are important: cohesion, centrality and connectivity (Burt, 1987; Ofem, Floyd & Borgatti, 2013).

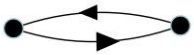
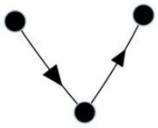
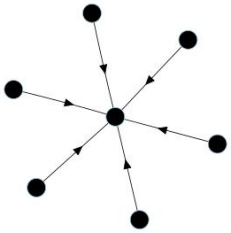
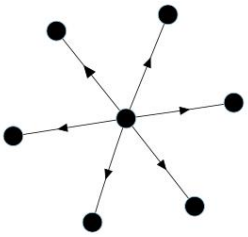
Cohesion concerns the extent to which network actors are directly connected to each other. Larger cohesion can be interpreted as a source for stronger relationships among network actors (Dion, 2000). Even though a number of parameters can be used to measure cohesiveness, two are particularly interesting for the current study's context: density and reciprocity. Network density is a measure of how well-connected all teachers are, calculated by dividing the total number of observed ASRs to those of all possible ones. Reciprocity manifests the symmetry between incoming and outgoing ties for each pair of network actors, as well as indicating quality of relationships (Krackhardt, 1992).

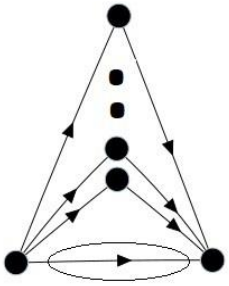
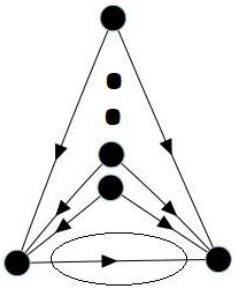
The concept of centrality captures the prominence of a network actor due to his/her positional advantage in the network. In the simplest term, centrality means the proportion of times that a network actor nominates others or is being nominated by others. A larger centrality value of a network actor means greater robustness for this actor on the network (Ofem, Floyd & Borgatti, 2013). However, the emergence of popular network actors can cause the other network members to be less connected, which skews the distribution of connectivity on the network (Borgatti & Ofem, 2010). In this study, we attend to in-degree and out-degree centrality parameters which indicate the number of sought and provided advice for each network actor respectively. Focusing on these parameters, our theoretical attention turns to multivariate network centrality of hybrid-expert teachers who allocate both technological and pedagogical knowledge resources for their networks. Thus, we can investigate whether hybrid-expert teachers occupy a central position in multiple advice networks due to their in-degree and out-degree centralities (Ryymin, Palonen & Hakkarainen, 2008).

In addition to cohesion and centrality features, the third crucial concept is the *connectivity* feature. Connectivity concerns indirect ASRs mediated through adjacencies, suggesting that particular interaction patterns linking two focal actors to a third party can produce similar consequences for the focal actors. Only when ASRs among three network actors are closed with a transitive tie established between two focal actors, could then we infer structural equivalence of these focal actors (Robins, Pattison & Wang, 2009). That is, transitive ties refer to the potential for triadic closure with inclusion of a new tie between a pair of actors if they are previously connected to the same third parties (Snijders, van de Bunt, & Steglich, 2010). Such transitivity may be viewed as an indicator of structural homophily in general terms (DiMaggio, 1986). Thus, controlling for the connectivity of teachers, we can examine the extent to which technological and pedagogical ASRs have transitive ties.

Some basic structural effect parameters with respect to cohesion, centrality and connectivity features are illustrated in Table 1. The arrowed ties represent the flow direction of ASRs. The transitive ties are circled to indicate social closure of local interactions by means of these ties.

Table 1. Structural Effects and Relevant Interaction Patterns

Structural Effects	Visualisation of Interaction Patterns	Interpretations
Arc		Baseline propensity for the occurrence of ASRs, indicating network density of ties.
Reciprocity		Tendency of teachers to have reciprocal ASRs, indicating mutual collaboration.
Simple Connectivity		Tendency of teachers to have equivalent incoming and outgoing ASRs, indicating the correlation between incoming and outgoing ties.
Popularity spread		Tendency for centralization in providing ASRs, indicating the presence of popular advice-provider actors on the network.
Activity spread		Tendency for centralization in seeking ASRs, indicating the presence of popular advice-seeker actors on the network.

Path closure		Tendency of teachers to give advice to a group of colleagues, also to give advice to another who seeks advice from the same group. It indicates the transitive closure of the network for the flow of knowledge.
Popularity closure		Tendency of teachers to be sought out for advice by a group of colleagues, also to seek advice from each other. It indicates the transitive closure of the network between popular actors.

In sum, social capital theory gives a clear explanation of why structural social capital (e.g. cohesion, centrality and connectivity of ASRs) matters and, in turn, is dependent on contextual factors of cognitive social capital (e.g. LO culture) in producing valuable ends (e.g. professional knowledge exchanges). Social network theory explains what particular structural effects and relevant interaction patterns are associated with individual and collective knowledge acquisition and exchanges among teachers (Moolenaar, 2014a).

Purpose and Research Questions

In light of the social capital, learning organisation and social network theories, we posit that teachers' ASRs – grounded in and shaped by their affiliation to advice networks – are associated with individual factors at micro-level, relational at meso-level, and organisational factors at macro-level. Firstly, we investigate to what extent teachers' ASRs regarding the use of ICT and pedagogical issues are influenced by multilevel factors. Secondly, we address the relatedness of simultaneous technological and pedagogical ASRs in different school settings (i.e. different levels of LO culture as perceived by teachers). Besides the investigated LO culture, critical to this relatedness is that a teacher's choice of whom to ask for advice is not only subject to an array of multilevel factors but also to the structural effects that can be differentiated by the subject matter of the advice sought. This is reflected in the idea

that each colleague may be unique for his/her capacity in a specific knowledge area (Borgatti & Cross, 2003); and, teachers who give advice might have expertise in more than one area as hybrid expert teachers (Hakkarainen, Palonen, Paavole & Lehtinen, 2004). For instance, a teacher might turn to a technology-savvy teacher for seeking advice on the use of ICT, but turn to another teacher or school principal for knowledge sharing about pedagogical issues. Or, alternatively, teachers might turn to the same colleague for both types of ASRs because of his/her hybrid-expertise in ICT use and pedagogical issues. To this end, a two-fold research design is implemented to answer the following two research questions (RQs):

RQ-1. To what extent do micro (i.e. gender, age, experience, departmental or administrative assignments), meso (interpersonal similarity of these features) and macro level factors (i.e. average teacher experience and perception of LO culture in schools) account for technological and pedagogical ASRs?

RQ-2. Which structural effects are associated with the relatedness of technological and pedagogical ASRs in distinct school contexts where teachers perceive high-level and low-level LO culture?

METHODOLOGY

Sample and Procedure

The data for this study were collected from a large urban district in Istanbul/Turkey. At the outset, we surveyed 1105 teachers' perception of LO culture in 69 Turkish state schools. The level of LO culture was measured and ranked by average teacher perceptions. Taking school's average LO culture as selection criteria, we divided 69 schools into top-half and bottom-half groups. Later on, we selected randomly 5+5 schools from the top-and bottom-half groups. A follow-up SNA questionnaire was administered to all teachers in the 10 schools selected. While measuring sociometric features of networks, reaching a minimum response rate of 70 percent in any network is recommended to obtain reliable estimates as a general rule (Borgatti, Carley & Krackhardt, 2006; Kossinets, 2006). Since the response rate of one school from the top-half group remained under the suggested percentage, we excluded that school from further analysis. As such, sociometric data of 339 teachers clustered in 9 schools were analysed to answer RQ-1. For RQ-2, multivariate advice networks collected from 3 schools did not converge with the data simulated by SNA. Thus, the last SNA regarding RQ-2 was carried out with the data drawn from 6 schools, including 186 teachers.

Measurement Instruments

*LO Questionnaire***.** The LO questionnaire is composed of two parts. In the first part, teachers responded to three questions regarding their gender, age, and number of years teaching at his/her current school. In prior research, these descriptive variables were usually treated as control variables to investigate their confounding effect on LO culture. (Garcia-Morales, Lopez-Martin, & Llamas-Sanchez, 2006; Leithwood, Leonard & Sharratt 1998). Accordingly, we factored in the effects of these variables on LO culture.

In the second part of the questionnaire, we used the Learning School Scale (LSS) developed for previous research by Çetin and Subaş (2014). The LSS scale consists of 30 items that are constructed around five sub-scales, based on LO characteristics of team learning, shared vision, systems thinking, personal mastery and mental models (Senge, 1990; Senge et al., 2000). As for its psychometric properties, the LSS explained 59% of the observed total variance with changing factor loadings in the range of .51 and .81 (KMO=.86; p<.001). Cronbach's α coefficients were found to be .93 (team learning), .91 (shared vision), 71 (systems thinking), .75 (personal mastery), and .71 (mental models), providing an acceptable internal consistency.

Out of the five subscales, the first measures teachers' personal mastery (e.g., "I am willing to join professional development activities"), and the second concerns teacher's mental models (e.g., "I respect differences of opinion as a learning opportunity for me"). The third subscale assesses teachers' perception of team learning (e.g., "There is goal congruence among teacher teams"), and the fourth one gauges the extent of shared vision (e.g., "Our school vision includes well-defined success criteria"). Finally, the systems thinking subscale gauges the presence of an overall mindset that draws on a comprehensive viewpoint (e.g., "Organisational problems arise from the previous actions we took"). Teacher responses are scored on a 4-point Likert type scale ranging from 1 (strongly disagree) to 4 (strongly agree).

SNA Questionnaire. The first part of the SNA questionnaire involved teacher demographics of gender, age, administrative or departmental headship status, and teaching experience in years at current school. In the second part, we used a name roster in which all names of a school's principal, vice-principal and teachers were listed by a name generator. By these lists, teachers were asked to nominate as many colleagues as they preferred about:

1: "To whom do you turn for seeking advice on the use of ICT in your school?"

2: “To whom do you turn for seeking advice on pedagogical issues in your school?”

Analytical Approach

SNA is a robust analytical approach derived from graph theory and matrix algebra. The graph theory suggests mathematical solutions that visualize real-life problems, depicting entities as nodes and their connections in matrices. For doing so, SNA makes use of sociometric measures drawn from dyads (i.e. ties between a pair of actors), triads (i.e. ties among three actors), multiple triads (i.e. ties among more than three actors) and networks as a whole.

The p2 Models. The p2 and exponential random graph models (ERGMs) are two advanced SNA models, which are separately used in this study to answer the two central RQs. For RQ-1, p2 models were performed since it allows for the inclusion of multilevel random effects of individual, dyadic and network-related independent variables on observed network data (Zijlstra & van Duijn, 2003). Ordinary logistic regression is not appropriate for estimating such random effects in SNA models because sociometric measures do not support the assumption of independent observations (Van Duijn & Vermunt, 2006). More properly, the p2 models predict the likelihood of interaction patterns of observed relationships as a function of (Zijlstra, Van Duijn & Snijders, 2006):

a) Network-related measures (i.e. context),

b) Dyadic measures (i.e. similarities and differences between individuals),

c) Individual measures (i.e. tendency for an individual actor to receive or give a tie).

In our p2 model, technological and pedagogical ASRs were used as dependent variables in two separate multilevel models. For every pair of teachers, we checked ASRs for differences in teacher’s gender, age, subject-field in middle and secondary schools, or grade-level in primary schools, administrative position (i.e. principal/vice-principal), and head-teacher status. Advice-seeking and providing covariates were also regressed on individual teachers’ characteristics at micro-level. As contextual background, we took into account LO culture and average teacher experiences in schools.

The Exponential Random Graph Models (ERGMs). In addressing RQ-2, we used exponential random graph models (ERGMs). Albeit fairly complex, methodological background underlying the ERGMs is well-grounded. Robins and Lusher (2013) articulate the five fundamental assumptions underlying ERGMs, as follows:

- Social networks are locally emergent.

- Network ties are interdependent.
- Interaction patterns are elements of ongoing structural construction.
- Multiple relationships can operate simultaneously.
- Social networks are structured, yet stochastic.

In adherence to these assumptions, ERGMs are composed of a set of structural effects (see Table 1) that are proposed to predict properties of the overall network. As distinguished from p2 models, ERGMs have extensions on multivariate networks so as to verify the relatedness of univariate networks by modelling structural effect parameters (Wang, Robins & Pattison, 2009). What is more, ERGMs allow researchers to set flexible models by which probabilistic prediction models can be specified according to theoretical interests. Nonetheless, beyond pure theoretical reasoning, selection of structural effects also requests empirical trial-and-error attempts to obtain satisfactory goodness-of-fit scores (Robins & Lusher, 2013).

Meta-Analysis. We carried out a meta-analytical procedure to evaluate the results of ERGMs within the top and bottom-half school groups separately. Following Lubbers and Snijders's (2007) meta-analytical approach, the results of ERGMs were combined in a unique table (see Table-4). In this approach, estimated errors of structural effect parameters are assumed to be independently and normally distributed with a mean of zero, and standard deviations equal to the estimated standard errors. The meta-analytical procedure was performed using MLwIN (Rasbash et al., 2000).

Descriptive SNA statistics were calculated using UCINET (Borgatti, Everett & Freeman, 2002). Advanced SNA procedures of p2 and ERGMs were carried out using StOCNet (Boer et al., 2006) and XPNET (Wang, Robins & Pattison, 2009), which are specialised computer programmes for analysis of multiple networks, dyadic/triadic interaction patterns and their probable antecedents.

RESULTS

To demonstrate descriptive findings, we tabulated the top and bottom half schools which are classified by the level of perceived LO culture, alongside their so-called school names, the number of teacher populations and participant teachers, density parameters peculiar to pedagogical and technological ASRs, and correlation coefficients between technological and pedagogical ASRs.

Table 2. Descriptive SNA Statistics

LO Culture	School Names	Teacher Population	Number of Participants	Response Rate (%)	Density of Ped. ASRs	Density of Tech. ASRs	Corr.
Top-Half Schools	School A	55	39	70.91	0.08	0.04	.16**
	School B	40	37	92.50	0.19	0.09	.19**
	School C	17	15	88.24	0.50	0.48	.94**
	School D	31	30	96.77	0.22	0.09	.29**
Bottom-Half Schools	*School E*	*49*	*48*	*97.96*	*0.13*	*0.07*	*.32***
	School F	*75*	*61*	*81.33*	*0.19*	*0.11*	*.45***
	School G	*42*	*33*	*78.57*	*0.14*	*0.88*	*.23***
	School H	*74*	*53*	*71.62*	*0.18*	*0.08*	*.30***
	School I	*31*	*23*	*74.19*	*0.17*	*0.11*	*.29***

As shown in Table 2, teachers' response rates of the SNA questionnaire are all above the threshold percentage of 70. The densest pedagogical ASRs were observed among 15 teachers in School C. In this school, half of the teachers are involved in pedagogical ASRs. The densest technological ASRs were observed among 33 teachers in School G. In this school, 88 percent of the participants turn to one another for pedagogical advice. Despite the relatively high density values of school C and G, the density scores of the other schools are rather low, implying rather sparse network structures.

Further, a very strong association between technological and pedagogical ASRs was obtained in School-C with a correlation coefficient of .94, implying that teachers who seek technological advice from a colleague have a strong tendency to seek pedagogical advice from the same colleague, and vice versa. Aside from School-C, the correlation coefficients between technological and pedagogical ASRs ranged between .16 and .45, indicating weak and moderate level correlations, but statistically significant.

Important to note is that descriptive SNA statistics, albeit insightful, are not a sufficient means to examine the relatedness of ASRs. The conventional approach behind these basic SNA statistics hinges on the independence assumption of observed ties. It disregards interdependence of relationships on the whole

(Boer et al., 2006). To fulfil this analytical gap, we analysed the influence of multilevel antecedents on ASRs using alternative SNA approach of p2 models assuming dyad independence (van Duijn, Snijders & Zijlstra, 2004).

RQ-1. To what extent do micro, meso and macro level factors account for technological and pedagogical ASRs?

In an attempt to answer RQ-1, micro, meso and macro level independent variables were tested for their partial effects on advice-seeking, advice-providing, density, and reciprocity covariates of ASRs. Results are presented separately for technological and pedagogical ASRs with estimated means, standard errors and reliability intervals. The significant estimates are assigned with an asterisk. The results are presented in Table 3.

Table 3. Multilevel Antecedents of Pedagogical and Technological ASRs

	Pedagogical ASRs (N= 9 Advice Networks)			Technological ASRs (N= 9 Advice Networks)		
	Mean	SE	95% CI	Mean	SE	95% CI
Overall mean						
Density	-2.17	.02		-2.86	.21	
Reciprocity	1.74	.19		1.72	.28	
Advice-Seeking Covariates						
Micro-level factors						
Gender (Male vs. Female)	.35	.25	(-.13/.83)	.37	.29	(-.18/.90)
Age	.01	.02	(-.05/.04)	.05	.02	(-.01/.09)
Experience in years	.02	.05	(-.06/.15)	.02	.06	(-.07/.15)
Administrative position	-.05	.71	(-1.17/1.61)	.54	.82	(-.67/2.14)
Departmental headship (Teacher vs. Head teacher)	.01	.31	(-.56/.63)	.43	.48	(-.56/1.21)
Advice-Providing Covariates						

Micro-level factors						
Gender (Male vs. Female)	-.91*	.28	(-1.51/-.45)	-1.62*	.31	(-2.26/-1.13)
Age	.01	.02	(-.02/.05)	-.02	.02	(-.06/.03)
Experience in years	.07*	.03	(.01/.12)	.02	.05	(-.07/.13)
Administrative position	1.40*	.41	(.62/2.24)	1.64*	.67	(.26/2.67)
Departmental headship (Teacher vs. Head teacher)	.20	.43	(-.46/1.35)	1.02	.70	(-.00/2.79)
Density Covariates						
Meso-level factors						
Homophily of gender	.67*	.06	(-.78/-.54)	.62*	.07	(-.75/-.48)
Homohpily of age	.01	.01	(-.01/.01)	.01	.01	(-.02/.01)
Homophily of experience	.03*	.01	(-.05/-.02)	.02*	.01	(-.03/-.00)
Homophily of administrative position	-.36*	.11	(.15/.55)	.05	.13	(-.34/.15)
Homophily of departmental position	.02	.08	(-.17/.15)	.10	.11	(-.32/.14)
Homophily of taught subject-field	13.18*	3.71	(3.32/18.26)	19.60*	7.20	(4.59/30.56)
Macro-level factors						
Average teacher experience	-.20	.31	(-.88/.38)	.58	.38	(-.15/1.23)
Average LO culture	.69	.59	(-.39/1.84)	-1.07	.86	(-2.49/.55)
Reciprocity Covariates						
Meso-level factors						
Homophily of gender	-.12	.17	(-.18/.47)	.01	.25	(-.49/.47)
Homophily of age	.01	.01	(-.03/.03)	.01	.02	(-.06/.04)
Homophily of experience	-.01	.01	(-.03/.03)	.03	.02	(-.08/.02)
Homophily of administrative position	.70*	.14	(-.97/-.43)	.66*	.22	(-1.09/-.22)
Homophily of departmental position	-.02	.17	(-.38/.29)	.06	.28	(-.71/.40)
Homophily of taught subject-field	-11.34*	3.99	(-16.89/-.95)	-17.29*	7.24	(-27.83/-1.97)
Macro-level factors						
Average teacher experience	-2.98*	1.03	(-4.92/-.98)	-.46	1.31	(-3.24/1.69)

Average LO culture	5.15*	1.74	(1.81/8.82)	.57	2.51	(-3.64/5.84)

As seen in Table 3, the overall means of density and reciprocity effects are controlled by default. Negative values of overall density effect (i.e. Mean=-2.17, SE= .02; Mean= -2.89, SE=.21) imply that both technological and pedagogical ASRs occur sparsely among teachers. Technically phrased, when the density or reciprocity parameters yield a negative value, this asserts the occurrence likelihood of such ties between two actors is lower than 50 percent. On the other hand, the findings of positive reciprocity effects suggest that these ASRs tend to occur reciprocally among teachers.

An examination of advice-seeking covariates shows that none of the micro-level factors enhanced the likelihood of seeking pedagogical or technological advice ($p>.05$). As for advice-providing covariates, male teachers had more tendencies to provide both pedagogical and technological advice than their female counterparts (Mean= -.91, $p<.05$; Mean= -1.62, $p<.05$). Likewise, a principal more likely than vice-principals, and vice-principals more likely than teachers, tended to give both technological and pedagogical advice to their subordinates (Mean= 1.40, $p<.05$; Mean= 1.64, $p<.05$). The higher teachers' experience at their current schools, the higher the likelihood of giving pedagogical advice to their colleagues (Mean= .07; $p<.05$). This was not true, however, for technological ASRs ($p>.05$).

Results with regard to density covariates suggest that similarity of gender (Mean= .67, $p<.05$; Mean= .62, $p<.05$), teaching experience (Mean= .03, $p<.05$; Mean= .02, $p<.05$), and taught subject-field (Mean= 13.18, $p<.05$; Mean= 19.60, $p<.05$) enhanced the occurrence likelihood of denser technological and pedagogical ASRs between these teachers. Remarkably, the results reveal that pedagogical ASRs are less likely to occur between administratively superior teachers and their subordinates (Mean= -.36, $p<.05$).

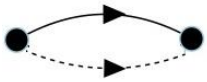
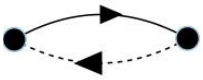
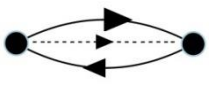
For reciprocity covariates, technological and pedagogical ASRs were found more likely to occur within the closed boundaries of superior and subordinate teacher groups in a reciprocal way (Mean= .70, $p<.05$; Mean= .66, $p<.05$). These relationships, however, are less likely to occur in a reciprocal way for cross-departmental interactions (Mean= -11.34, $p<.05$; Mean= -17.29, $p<.05$). In schools where teachers reported higher years of teaching experience on average, the density of pedagogical ASRs was found to be lower (Mean= -2.98, $p<.05$). One of the key findings is that the higher teachers perceived the LO culture, the more teachers had a tendency to form pedagogical ASRs in a reciprocal way (Mean=

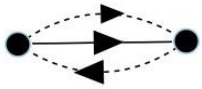
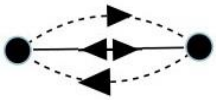
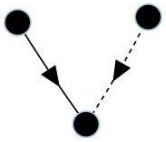
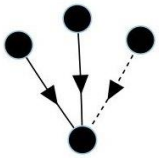
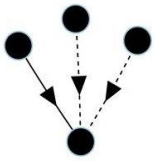
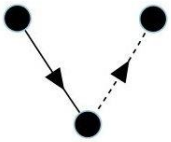
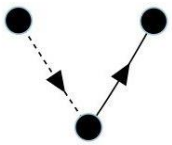
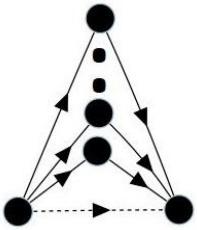
5.15, p<.05). This last finding justifies our second research question that investigates whether structural effects can play a determining role in the relatedness of technological and pedagogical ASRs depending on the perceived differences in LO culture.

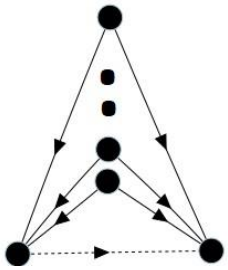
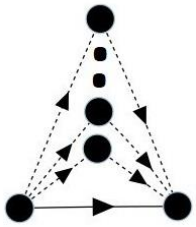
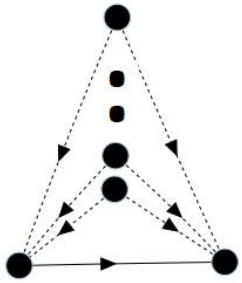
RQ-2. Which structural effects are associated with the relatedness of technological and pedagogical ASRs in distinct school contexts where teachers perceive high-level and low-level LO culture?

For this second research question, we shift the focus to a set of structural effects by which teachers may follow particular interaction patterns for simultaneous technological and pedagogical ASRs. Once structural effects were separately estimated for 6 schools, meta-analysis of the proposed univariate structural effects (see Table 1) and corresponding multivariate versions of those (see Table 4) were carried out within the top and bottom-half schools separately. Because of the limited word count, the results from univariate ERGMs were not reported in the paper. The results arising from the meta-analysis of multivariate ERGMs are presented below together with estimated structural effect parameters, their standard errors, standard deviations, and χ^2 parameters which verify within-group variance distribution. The significant structural effect parameters are assigned with an asterisk.

Table 4. Meta-analysis of Multivariate ERGMs

Structural Effects	Visualization	Top-half Schools with High-Level LO Culture (N=3 advice networks)			Bottom-half Schools with Low-Level LO Culture (N=3 advice networks)		
		Est. (SE)	*SD*	χ^2	*Est.(SE)*	*SD*	χ^2
Overlapping Arcs		2.77 (.06)*	.93	3.71	3.27 (1.86)	3.09	1.54
Mixed Reciprocity (PT)		.88 (.26)*	.00	.00	.89 (.43)*	.00	.00
Mixed Reciprocity (PPT)		-1.28 (.36)*	.00	.00	.09 (.59)	.00	.00

Mixed Reciprocity (PTT)		-.96 (1.17)	1.67	1.27	2.23 (2.61)	4.40	6.95*
Mixed Reciprocity (PPTT)		2.06 (1.40)	1.52	1.48	n/a	.00	.00
Mixed Popularity (In-2-Star-PT)		.12 (.03)*	.00	.00	.13 (.25)	.38	.62
Mixed Popularity (In-3-Star-PPT)		-.01 (.00)*	.00	.00	-.02 (.03)	.04	1.10
Mixed Popularity (In-3-Star-PTT)		.01 (.00)*	.00	.00	.02 (.00)*	.00	.00
Mixed Connectivity (PT)		.02 (.04)	.05	.58	.01 (.01)	.14	.67
Mixed Connectivity (TP)		-.03 (.05)	.08	2.55	-.05 (.05)	.05	1.03
Mixed Path Closure (PPT)		-.01 (.15)	.18	.44	.14 (.32)	.40	.42

Mixed Popularity Closure (PPT)		.11 (.24)	.32	.28	-.38 (.26)	.28	.68
Mixed Path Closure (PTT)		-.10 (.18)	.26	.92	.01 (.26)	.26	.59
Mixed Popularity Closure (PTT)		.48 (.11)*	.15	.98	.52 (.17)*	.14	.69

Results show that overlapping pedagogical and technological ASRs were more likely to come into existence in the top-half schools (Est.= 2.77, SE= .06). In order to examine the likelihood of reciprocally simultaneous ASRs, four types of multivariate mixed reciprocity effects were added into ERGMs. The first type of mixed reciprocity effect (i.e. PT), including one-way pedagogical and one-way technological advice ties, was found to be significantly positive both in the top and bottom-half schools (Est.= .88, SE= .26; Est.= .89, SE= .43), implying that teachers tend to seek technological advice from colleagues as they, in return, give them pedagogical advice, and vice versa. The second type of mixed reciprocity effect (i.e. PPT), including two-way pedagogical but one-way technological advice ties, were found to be significantly negative in the top-half schools (Est.= -1.28, SE= .36). However, in the bottom-half schools, this effect was found to be insignificant (p>.05). In other words, teachers from the top-half schools did not prefer to seek technological advice from colleagues with whom they already exchanged pedagogical advice. The third type of mixed reciprocity effect (i.e. PTT) was found to be insignificant (p>.05), although it produced a remarkable variation in chi-square tests (SD=4.40, χ^2=6.95). The fourth type of mixed-reciprocity effect (i.e. PPTT), including two-way pedagogical and technological advice

ties, was found to be insignificant in the top-half schools (p>.05). Since there were no reciprocal ties in two schools from the bottom-half group, meta-analysis of this structural effect was not applicable for the remaining one school.

The mixed popularity effect including two simultaneous incoming technological and pedagogical advice ties (i.e. In-2-Star-PT) was found to be significantly positive in the top-half schools (Est.= .12, SE=.03), suggesting that there are some hybrid experts who are equally sought out for both pedagogical and technological advice in these schools and that they were more likely to occupy a central position in advice networks. The second type of the mixed popularity effect with three simultaneous incoming advice ties, depicted by two pedagogical and one technological ASRs (i.e. In-3-Star-PPT), was proved to be significantly negative in the top-half schools (Est.= -.01, SE= .00). This suggests that the hybrid experts who are sought out for pedagogical advice twice as much as technological advice were less likely to occupy a central position in the top-half schools. The last type of mixed popularity effect with three simultaneous incoming advice ties, depicted by one pedagogical and two technological ASRs (i.e. In-3-star-PTT), was found to be significantly positive in the top and bottom-half schools (Est.= .01, SE= .00; Est.= .02, SE= .00). That is to say, the hybrid experts who are sought out for technological advice twice as much as pedagogical advice were more likely to occupy a central position in all schools. With regard to structural equivalence of multiple ASRs, the mixed popularity closure (PTT) was found to be significantly positive in both the top-half and bottom-half schools (Est.= .48, SE=.11; Est.= .52, SE=.17). This means that some technology-savvy teachers who are sought out for technological advice by the same group of colleagues were more likely to seek pedagogical advice from each other in general.

DISCUSSION AND CONCLUSION

Social capital is manifested through interactions mediated by cultural norms and values (Frank, 2009). Yet, little research has been undertaken to understand which individual (micro-level), relational (meso-level) and organisational (macro-level) factors may induce teachers to engage in technological and pedagogical ASRs. And even, to a lesser extent, scholarly attention has been paid to the relatedness of simultaneous advice exchanges on technological and pedagogical issues (Ryymin, Palonen & Hakkarainen, 2008). In an effort to fulfil these research gaps, our study breaks new ground by identifying multilevel antecedents of ASRs and obvious structural effects whose interaction patterns were followed by teachers in seeking simultaneous technological and pedagogical advice. In the following paragraphs, the results regarding the two central research questions in this study, are outlined.

Multilevel Antecedents of ASRs

The more individuals are connected, the more they can be influenced by contextual background of the network (Coleman, 1988). Density is one of the cohesion-related measures that gives the proportion of actually observed ties out of all possible ones. Reciprocity is another measure of the cohesion, which represents the number of mutual ties between individuals (Wasserman & Faust, 1994). As a baseline propensity, our study yielded negative values for the overall density effect that flag a potential problem about the cohesion of ASRs. Descriptive statistics also confirmed this flaw, by network density values lower than .23 in 7 out of 9 schools. Nonetheless, it is important to note that estimated positive values pertaining to the overall reciprocity effect may be viewed as indicators of qualification in ASRs because they tend to occur in a reciprocal way, as a baseline propensity.

Consistent with earlier research that has demonstrated that multilevel factors are associated with how teachers form professional interactions (Frank & Zhao, 2005; Moolenaar et al., 2014a), our findings show that teachers' individual experience, gender, administrative position at micro-level, similarity thereof at meso-level, and the average teacher experience and perception of LO culture at macro-level are related to ASRs regarding technological and pedagogical issues. In line with Moolenaar's (2010) study, we revealed that the more experienced teachers become, the more central position they occupy in providing pedagogical advice. A general conclusion in network studies is that social relationships are to a greater extent homophilous concerning teaching experience (McPherson et al., 2001). Likewise in our study, we found that teachers with similar years of experience had more tendency to engage in technological and pedagogical ASRs. In addition, previous research has concluded that teachers have more tendency to contact each other when they share a common past experience (Coburn & Russell, 2008; Moolenaar et al., 2014a). Yet, our research came up with a contrasting conclusion in this matter, showing that the more years of experience teachers share, the less they establish reciprocal ASRs on pedagogical issues. One explanation could be that teachers who have a lot of experience in the school, might consider themselves as expert teachers about pedagogical issues, and as such find it unnecessary to establish mutually reinforcing ASRs around pedagogical issues with other experienced teachers in the school context. When the average experience of the teacher community decreased, teachers may be more relaxed about seeking pedagogical and technological advice from other similarly less experienced teachers. In order to turn such a high level of average teacher experience into an advantage for social capital accumulation, we suggest that educational policy makers and school

leaders should introduce well-planned incentive regulations stimulating experienced teachers to establish mutual collaboration among colleagues.

As we controlled for the influence of teachers' gender at micro and meso levels, male teachers occupied a more central position on advice networks, as they are more likely to provide technical and pedagogical advice than their female colleagues. Although this finding is inconsistent with Moolenaar's (2010) findings which were in favour of female teachers in Dutch elementary schools, we note that our research comprehensively covers all K-12 education levels unlike Moolenaar's research. Due to the fact that this research focuses on ICT related advice exchanges, it could also be an explanation for the more central position of males instead of females. Besides, this difference could also be the result of distinctive cultural contexts in Dutch and Turkish schools.

Additionally, teachers' departmental affiliations were included in our p2 model at micro and meso levels. As a result, we found that it was more likely that reciprocal ASRs came into existence between teachers from different departments. In educational literature, there are controversial findings regarding the relevance of departmental positions to teacher collaboration. For instance, Spillane, Hopkins and Sweet (2015), and, Penuel and colleagues (2010) showed that teachers from the same grade-level are more likely to interact with each other than other colleagues from different grade-levels. By contrast, Brennecke and Rank (2016) showed that members of informal teacher sub-groups including multiple departmental members have more tendency to seek advice from each other rather than turning to colleagues from the same department. Complementing this last finding, we also showed that holding a departmental headship position is not related to an increase or decrease in the likelihood of advice seeking and/or providing. Yet, Spillane and Hopkins (2013) conversely concluded that departmental headship plays a crucial role in the formation of ASRs in elementary schools. As for the cross-departmental reciprocity of technological ASRs, a similar finding to our study was reported by Hiltz (2011), in which reciprocal advice-seeking tendency for technological ASRs was far more observed between teachers who work in different departments. Hiltz (2011) interpreted a similar finding based on existing informal teacher subgroups in that reciprocal relationships may entail stronger informal ties that may go beyond formal assignments in schools. Also another plausible reason for the emerging cross-departmental ties is that mutual collaboration on the use of ICT requires both teachers to have a technical expertise for transmitting such technical knowledge (Ryymin, Palonen & Hakkarainen, 2008). Thus, we interpret that such pairs of technology-savvy teachers who are mutually connected are

statistically far more likely to be observed throughout the overall teacher population than within departmental boundaries.

A number of studies concluded that school principals, vice-principals and head teachers are natural advice-providers because of their formal leadership positions, though, their centrality can vary to a greater extent (Moolenaar, Daly & Sleegers, 2010). To verify this claim, a teacher's administrative position, coded as principal or vice-principal, was controlled at micro and meso levels. We revealed that teachers' administrative superiority induces them to provide technological and pedagogical advice to their subordinates. Furthermore, pedagogical ASRs were found more likely to occur between superiors and subordinates at meso-level. However, these kinds of cross-positional interactions were not supported by empirical evidence on technological ASRs. Instead, teachers who hold the same position at administrative ranking had more tendency to establish reciprocal ASRs on both technological and pedagogical issues. Coupled with our previous findings, we can conclude that teachers tend to engage in reciprocal ASRs with colleagues outside their departments and with those without an administrative position. This result underscores the importance of informal professional interactions rather than formal ones, structured by teachers' departmental affiliations (Frank, 2009).

One of the most relevant results for the purpose of this study with regard to social capital is that teachers' average perception of LO culture, as proxy for the cognitive social capital in schools, contributed to the occurrence likelihood of pedagogical ASRs in a reciprocal way that promotes the quality of structural social capital. Hence, our study extends the current literature beyond earlier findings of the importance of commitment to shared school values (Frank & Zhao, 2005), and an innovative school climate (Moolenaar et al., 2014b). The current study suggests that if a school's cultural context promotes higher level of LO culture, this intensifies mutual teacher collaboration by means of an increase in cohesion of pedagogical ASRs. Likewise, Frank (2009) asserts that teachers who identify themselves with the school collective can override relationships with specific others, and thus this cultural context gives a base for solidarity among teachers. Teacher collaboration arises in appropriate school contexts in which sustained collaborative efforts are needed to solve organisational problems and build knowledge together (Hakkaraienen, Palonen, Paavola & Lehtinen, 2004).

Given the relatedness of different types of ties, social capital and social network theories highlight the crucial role of the connectivity feature in networks (Burt, 1992). Therefore, besides cohesion and centrality features, an investigation of the connectivity between simultaneous technological and

pedagogical ASRs, as proposed in the second RQ, is crucial to understand how structural effects could bring about an interplay depending upon existing LO culture in schools (Siciliano, 2017).

Structural Effects on ASRs

The results arising from our study disclosed essential structural effects for modelling a multivariate and simultaneous network structure that combines technological and pedagogical ASRs. The significance of the overlapping ASRs points to a tendency for simultaneous ties to be entrained between technological and pedagogical ASRs, particularly in the top-half schools. In particular, in the schools with the higher perceived LO culture, more teachers tend to seek technological advice from particular colleagues who are also sought out for pedagogical advice, and vice versa. Seeing that this relatedness lacked empirical support for technological ASRs in the bottom-half schools, we suggest that LO culture reinforces a positive school culture in which the hybrid experts to whom other teachers turn to for both technical and pedagogical advice plays a central role in advice networks (Ryymin, Palonen & Hakkarainen, 2008).

The overall significance of the mixed reciprocity (PT) effect refers to the extensiveness of "give-and-take" type social exchanges, regardless of the level of existing LO culture. In other words, teachers tend to give technological advice, if they, in turn, receive pedagogical advice, and vice versa. Unlike such responsive interactions conducive to social exchanges (Blau, 1964; Cook & Emerson, 1978), social capital taps into the kind of interactions in which all parties allocate some valuable resources to their community, putting faith in the collective values and entity of the community, and without anticipating immediate benefits from the community members in return (Coleman, 1988). In this manner, the estimated negative significance of mixed reciprocity (PPT) in the top-half schools shows that teachers who work in these schools are less likely to prefer seeking technological advice from colleagues with whom they simultaneously have advice exchanges concerning pedagogical issues. Together with our previous findings, this can be interpreted as a signal of the centralization of incoming ties flowing towards hybrid experts, as they tend to provide both technological advice and pedagogical advice without receiving pedagogical advice in turn. Likewise, the mixed popularity effect (In-2-Star-PT) confirms the in-degree centrality of hybrid experts in the top-half schools. Furthermore, the mixed popularity effect (In-3-Star-PTT) signals the overall skewness in the centrality distribution when the hybrid experts are sought out more for technical advice than pedagogical advice. The mixed popularity effect (In-3-Star-PPT) proved to be significantly negative in the top-half schools. This means that the preferability of

hybrid-expert teachers for being sought out for technical advice increases their overall centrality to be sought out for both technical and pedagogical advice in the top-half schools. Our results are partly in line with findings from a previous study of Ryymin, Palonen and Hakkarainen (2008), suggesting that when there are few hybrid-expert teachers in advice networks, technical and pedagogical expertise of those are more probably interrelated. Additionally, we revealed that technological expertise of hybrid-expert teachers is more influential to their network centrality than pedagogical expertise, if the overall teacher community in their schools perceives a higher level of LO culture. Furthermore, the significant and positive value of the mixed popularity closure effect (PTT) uncovers the presence of transitive pedagogical ties between teachers who are popular for their technical expertise. That is, some technology-savvy teachers are more popular and well-connected by transitive ties whereby they seek pedagogical advice from each other. As far as we know this is the first time that the emergence of transitive pedagogical ties between technology-savvy teachers were evidenced.

Based on our findings, we can draw some implications for policy and practice. To improve teacher collaboration, school leaders should promote informal professional interactions among teachers by inspiring a positive school-wide professional learning culture. For this purpose, they can leverage the five learning organisation characteristics of team learning, shared vision, systems thinking, personal mastery and mental models in schools. While building professional learning teams, school leaders should be aware of individual and relational teacher characteristics relevant to teachers' decisions about to whom they turn for seeking advice. Besides, educational policy makers should focus on hybrid experts in particular for their potential to be informal professional learning leaders in teacher communities. Their ICT-related knowledge and skills should be further improved so that existing technical expertise makes them more popular to be sought out for further pedagogical and technological advice.

Although many different factors can influence ASRs among teachers, a limited number of micro, meso and macro level factors are set forward in the current research. For instance, networking positions of ICT coordinators were not examined in this study since there were only four ICT coordinators in our research population. Nevertheless, they seem to be the most proper network actors that might have been nominated for collaboration on the use of ICT. This is a main limitation of the current research and it should be examined in future research. Because of the convergence issue confronted in probabilistic SNA applications, our study is limited with meta-analysis of the ERGMs generated from 6 convergent

advice networks in 6 schools. Further research involving a greater number of schools is needed as a precaution against this technical limitation.

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CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

Abstract

In this final chapter, we provide a general conclusion and discussion of the present dissertation that tackles four different issues: school principals' technology leadership (TL) practices, school's learning organisation (LO) culture, ICT coordinators' ICT self-efficacy, and technological and pedagogical advice-seeking relationships (ASRs) among school actors (i.e. school principals, vice-principals, ICT coordinators and subject-field teachers). Our general aim is to gain a more comprehensive insight into ICT integration in K-12 schools, both internationally and context-specifically for Turkey. This final chapter opens with a reiteration of the introduction and research questions raised in this dissertation. Next, we give an overview of the major obtained results for each research question. Based on the evidence resulting from four empirical studies we conducted, special attention is paid to the discussion in this chapter. The discussion section is structured around three core themes: 1) reciprocal relationship between school principal's TL practices and school's LO culture, 2) indicators of ICT coordinator's professional self-efficacy, 3) interrelatedness of technological and pedagogical ASRs. Under each theme, significant findings from the previous chapters, discussions, contributions, limitations, and implications are presented. Finally, this chapter provides implications for educational policy makers, practitioners and scholarly researchers who are interested in studying ICT integration or ICT implementation in K-12 schools.

INTRODUCTION

As pointed out in the introduction section of this dissertation, the integration of ICT into school settings has mainly been explored by two streams of research with distinct foci (Venkatesh et al., 2003): 1) individual reactions to ICT adaptation, and 2) organisational change accompanying the introduction of ICT. Research in the second stream yielded various holistic models of ICT integration with the inclusion of individual, structural, and sociocultural factors (e.g. Lim, 2002; Tearle, 2004; Tondeur, Valcke & van Braak, 2008; Vanderlinde & van Braak, 2010). Out of these factors that all models have in common, we underline the importance of three sociocultural factors in particular. First, leadership practices are considered as an essential element of school's sociocultural context, which refers to the extent which school principals perform supportive technology leadership (TL) practices for the integration of ICT into school setting (Devos et al., 2007). Several studies suggest that effective TL practices are critical to the success of ICT integration implementations (Dexter, 2008; Hadjithoma & Karagiorgi, 2009; Hayes, 2007; Tondeur et al., 2008). Second, the presence of a positive school culture is another sociocultural factor, which promote teachers' professional development and the readiness of a school to ICT integration implementations (Dexter, Anderson & Becker, 1999; Tearle, 2003). Third, professional interactions - in terms of professional support - among school actors are considered subject to a sociocultural transformation which is undergone by drastic changes in the patterns of teacher collaboration (Frank, 2009; Siciliano, 2016; Zhao & Frank, 2003).

While addressing these sociocultural factors, we do not focus on investigating individual teacher reactions as in the first stream, or adding new factors to the "almost exhaustive list" of the second stream; the present dissertation contributes to the call for realising a so-called ecological perspective to study the multiple relationships among these factors known to be directly or indirectly associated with ICT integration (Zhao & Frank, 2003). Such an ecological perspective (Nardi & O'Day, 1999) means that people, their organisational behaviours, cultural values, and ICT using practices are operationalised in the way of mutual relationships. Indeed, the presence of such mutual relationships among sociocultural factors was largely acknowledged in the research literature, but has also been left unexplored by empirical studies (Hennessy, Deaney, & Ruthven, 2005; Vanderlinde, 2009). For this reason, in the present dissertation we addressed this lack of evidence by conducting four empirical studies, each reported in separate chapters (Chapters 2 to 5).

To reduce the conceptual ambiguity resulting from the wide connotation of sociocultural factors, we assign these factors to three sets of variables. That is, 1) we take technology leadership (TL) practices as a proxy for the supportive leadership practices of school leaders and principals (Richardson et al., 2012); 2) learning organisation (LO) culture for the positive school culture that promotes teacher development (Dexter, 2008; Divaharan & Lim, 2010); and 3) advice-seeking relationships (ASRs) for professional interactions and support among school actors (Siciliano,2016). LO culture is manifested through the development of five professional learning orientations in schools (Senge et al., 2000): team learning (i.e. active engagement in generative dialog with other colleagues); shared vision (i.e. collective aspiration for school values); systems thinking (i.e. critical inquiry about the source of organisational problems); personal mastery (i.e. aspiration for professional self-development); and mental models (i.e. self-reflection on the cause and effect relations in human actions). TL practices are evaluated by the extent to which school principals comply with visionary leadership, digital-age learning culture, excellence in professional practice, systemic improvement, and digital citizenship standards. These practices are based on the International Society for Educational Technology for Administrators (ISTE-A, 2009). ASRs are formed by the network of formal and informal ties between teachers and between teachers and their leaders, which also constitute the most common form of teacher collaboration in schools (Penuel et al, 2012).

In the following, we provide a brief overview of the four research objectives that seek to uncover the relationships between these three sets of variables in chapters 2, 3, and 5; and to develop a research instrument for measuring ICT coordinators' professional self-efficacy reported in chapter 4.

Overview of the Research Objectives and Analytical Approaches

The central aim of this dissertation is to understand how these three sociocultural factors interplay in the current models of integration and implementation of ICT in K-12 schools. While doing so, we statistically control for the availability of ICT infrastructure as a structural factor involved in the relationship of sociocultural factors. Besides, we examine another structural factor (i.e. the quality of internal ICT support) by developing a research instrument for the assessment of ICT coordinators' professional self-efficacy levels and demonstrate its reliability and validity. As before described and illustrated in the introductory chapter (see Figure 1, Chapter1), the following four research objectives are addressed in this dissertation:

Research Objective 1 (RO 1): To examine the predictive ability of teachers' perception of LO culture to TL practices;

Research Objective 2 (RO 2): To examine the predictive ability of school principals' TL practices to school's LO culture;

Research Objective 3 (RO 3): To develop a research instrument that measures professional self-efficacy levels of ICT teacher; and

Research Objective 4 (RO 4): To delineate teachers' professional interactions through their technological and pedagogical ASRs.

For RO 1, the first study explores the extent to which a school's LO culture contributes to a school principal's TL practices that are profiled by ISTE-A (2009) standards. In a reverse way, for RO 2, the second study examines the extent to which school principals' TL practices contribute to school's LO culture as perceived by teachers. For RO 3, in the third study we developed the first Turkish research instrument that is able to assess the extent to which a Turkish ICT coordinator's professional self-efficacy complies with the performance indicators in the "National Competency Framework for ICT Coordinators" (TMONE, 2008). In the last empirical study, for RO 4, professional interactions among school actors were challenged to understand how differently technological and pedagogical advice-seeking relationships (ASRs) are interrelated in the schools where teachers perceive a high or low level LO culture (as described in chapter 3).

All research objectives were investigated using quantitative methodological methods. Given the multilevel nature of the data collected from teachers nested in schools for RO 1 and RO 2, and the relational nature of the sociometric data binary-coded for investigating ASRs between teachers for RO 4, we used different analytical approaches that are ideally suited to gain insight into the research objectives. More specifically, RO 1 and RO 2 have been examined using latent class analysis (LCA) and logistic regression analyses. RO 3 has been tackled by following the conventional scale development stages suggested by Schwab (1980), i.e. item development, scale construction and scale evaluation. And for RO 4, a cutting-edge analytical approach has been undertaken to examine technological and pedagogical advice exchanges among teachers in connection, namely p2 and exponential random graph models (ERGM) strands of social network analysis (SNA).

Overview of the Chapters

Chapter 1 comprises a general literature review on ICT integration models, the contextual background of Turkey's first national ICT integration and implementation policy - the Fatih project -, and the theoretical framework on which we build the present dissertation. At the end of chapter 1, an overview of the four empirical studies are outlined and visualised to demonstrate how these chapters are related to each other.

The first empirical study is described in chapter 2. In this chapter, we mainly explore the predictive ability of LO culture to TL practices performed by school principals. For this purpose, a twofold research design is undertaken, and two research questions are respectively posed: 1) In which profiles can school principals' TL practices be clustered?, and 2) To what extent are principals' demographic features, computer and internet usage, schools' existing LO culture and ICT infrastructure able to predict these TL profiles? In answering to the first question, school principals are statistically clustered into distinct sub-groups through the latent class analysis (LCA). Each sub-group designates a TL profile whose members, i.e. school principals, reported similar features in relation to their self-report of performing ISTE-A (2009) standards (i.e. visionary leadership, digital-age learning culture, excellence in professional practices, systematic improvement, digital citizenship). As a result, this clustering analysis produced two TL profiles that distinguish school principals' low and high level of TL practices. LCA produced quite different levels of performance scores according to ISTE-A standards in each profile, but a similar order of mean performance scores for both profiles. That is, regardless of the profile under which they are grouped, school principals reported lesser performance in the "systemic improvement" standards than other ISTE-A standards. The school principals performing higher level of TL practices did so in all ISTE-A standards than those who perform lower level of TL practices. Yet, regardless of performing already higher level of TL practices, those school principals reported the greatest performance in the "digital citizenship" standards than others. Our descriptive findings revealed that almost 55% of the principals can be clustered under the high-level TL profile structure because they show greater interest in TL practices, whereas 45% of the principals can be classified into the low-level TL profile because of their relatively poor interest in TL practices. Second, the emerging TL profiles are regressed on teacher's perception of LO culture. The most striking result of the logistic regression analysis is that Turkish school principals are more likely to perform higher level TL practices if they a)

manage a technology-enriched Fatih project school; b) use internet technology more frequently, and c) manage a school in which teachers perceive higher level of “team learning” LO culture.

The second empirical study is described in Chapter 3. In comparison with the first study, in this second study, we ‘switch’ the dependent variable (i.e. profiles of LO culture) and independent variables (i.e. school principal’s TL practices), while controlling for teacher’s gender, age, years of experience, and school stage. The underlying rationale that drives us to make this change between dependent and independent variables is to verify the extensive research base demonstrating the contribution of school leadership to school’s LO culture for ICT integration research (Leithwood, Harris, & Hopkins, 2008; Fullan, 1995, 2010; Harris & Jones, 2015). Based on this reasoning, in the second study we set out to investigate the predictive ability of TL practices to the LO profiles as perceived by teachers, after controlling for the effect of other variables like teacher gender, age, teaching experience by years, and school’s educational stages - primary, middle and secondary schools. Again, a twofold research design is carried out and the following two research questions lead this study: 1) What are the distinct profiles of LO culture endorsed by teachers?, 2) To what extent are school principals’ TL practices, teacher gender, age, years of experience, and school stage able to predict the emergent LO profiles? As a result, teachers’ perception of LO culture with regard to their “personal mastery” and “mental models” (i.e. individual orientations) as well as the “systems thinking”, “team learning” and “shared vision” (i.e. school based) professional learning orientations, are statistically clustered in three LO profiles. Based on the mean teacher perception scores obtained from their professional learning orientations, emerging profiles are named as high, moderate and low level LO profiles. The high and low-level LO profiles are characterised by a great level difference between individual and school-based professional learning orientations. The moderate level LO profile yields the minimum variance and mean differences between the five professional learning. As such, in line with the theoretical inferences of Fritz (1989), this moderate level LO culture is labelled as the realistic approach. In the second stage of this study, the resulting three LO profiles are regressed on school principals’ TL practices. The findings from the logistic regression analysis indicate that teachers are more likely to perceive the high-level LO profile in schools where school principals reported higher level of performing “systemic improvement” standard in their TL practices. More concisely, school principals’ systemic improvement oriented TL practices appear to have an influence over teachers’ overall professional learning orientations, and thus school’s LO culture. This means that the school principals who use digitalised data in performance assessment and

evaluation, seek strategic partnership with other organisations, and recruit ICT-skilled staff to a greater extent; are more likely to build a higher level of LO culture as perceived by teachers. Besides, this study further indicates that elderly teachers, and middle-school teachers are more likely to perceive the high-level LO profile, compared to the moderate-level LO profile.

Chapter 4 contains the third empirical study, which reports psychometric properties of a newly developed valid and reliable research instrument to assess Turkish ICT coordinators' professional self-efficacy. Specifically, this scale development study seeks to answer the following research question: Does the research instrument developed in this study yield an acceptable level of reliability and validity to measure ICT coordinators' professional self-efficacy? To answer this question, an item pool with 53 items was initially generated by reviewing the National Competency Framework for ICT Coordinators (TMONE, 2008). Next, we examined the content and face validity of these draft items. For doing so, we asked for four scholars' expert opinions about the draft items, who work in the Computer Instruction and Technology Education department of three Turkish universities. Based on their expert opinions, we reduced the number of items to 45 ones. Later, we checked the construct validity of the remaining items by principal component analysis (PCA) and confirmatory factor analysis (CFA). PCA resulted in a seven-factor solution with 34 items, which accounts for 65.90% of the total variance. After one item was eliminated because of high value of standardised residual, CFA yielded the final seven-component solution with 33 items. Therefore, we came up with a new and psychometrically sound measurement instrument that is able to assess Turkish ICT coordinators' professional self-efficacy levels. The emerging seven components were named in accordance with the seven competency fields described by TMONE (2008), such as mastery of instructional design, using ICT-related concepts properly, measurement and evaluation tools, hardware and software equipment, multimedia applications, instructional software, and safe and ethical ICT use.

The fourth empirical study is described in Chapter 5. In this last empirical study, we shift the research focus towards on-the-job professional interactions that teachers develop with other teachers, school principals, vice-principals etc. We specified these interactions as advice-seeking relationships (ASRs) about technological and pedagogical issues they encountered. Technological issues refer to the subject of ASRs which is about the use of ICT for instructional purposes. Pedagogical issues define this subject in terms of the repertoire of teaching strategies. While handling these two types of ASRs, we take individual (micro-level), relational (meso-level), and school-related (macro-level) factors into

consideration as they are able to influence ASRs among teachers. Moreover, we compare the interrelatedness of such interaction patterns in those schools with a high and low level LO culture. The level of LO culture is measured based on teacher perceptions in 69 schools. Taking 69 school's average LO culture scores as selection criteria, we classify these schools into top-half and bottom-half groups. Later on, we select randomly 5+5 schools from the top-and bottom-half groups. Since one of the selected schools produced a low response rate under 70%, the sociometric data of 339 teachers in 9 schools were included in the analysis. This final empirical study is guided by two research questions: 1) To what extent do micro (i.e. gender, age, experience, departmental or administrative assignments), meso (interpersonal similarity of these features), and macro level factors (i.e. average teacher experience and perception of LO culture in schools) account for technological and pedagogical ASRs?; and 2) Which structural effects are associated with the relatedness of technological and pedagogical ASRs in distinct school contexts where teachers perceive high-level and low-level LO culture?

The results from the first research question showed that male teachers were found to have more tendencies to give both pedagogical and technological advice to colleagues than their female counterparts. Similarity of gender, teaching experience by years, and teaching the same subject-field enhanced the occurrence likelihood of denser technological and pedagogical ASRs. This means that teachers with less of an age difference, of the same gender, and within the same subject-field are more likely to contact each other for technological and pedagogical ASRs. Furthermore, pedagogical ASRs were found to be less likely to occur between administratively superior teachers and their subordinates. Technological and pedagogical ASRs occurred more reciprocally between teachers positioned within the same administrative rank (i.e. teacher-to-teacher, vice-principal-to-vice-principal). Contrastingly, they seemed to be more one-sided between teachers who teach different subject fields. That is, the teachers from different departments are more likely to only receive or provide technological and pedagogical advice to each other, but less likely to do so in a reciprocal way. The more the average age of teachers increased in a school, the less teachers engaged in pedagogical ASRs with colleagues in that school. One of the most important findings showed that teachers' perception of the high-level LO culture increased the likelihood of pedagogical ASRs among teachers. In other words, teachers were more likely to establish pedagogical ASRs in the schools where they perceived a higher level of LO culture on average. This result indicates that a positive school culture as perceived by teachers supports professional interactions among school actors. For the second research question, we compared the

patterns of ASRs between two groups of schools with the high and low-level perceived LO culture. The results from the second research question revealed that, regardless of the perceived LO culture – that is, in the same way in both groups-, teachers were more likely to seek technological advice from a colleague to whom they gave pedagogical advice, and vice versa. Again, irrespective of the perceived LO culture, the more teachers gave technological advice, the more they were sought for pedagogical advice in return, and vice versa. This means that give-and-take type of ASRs are prevalent independently of the perceived LO culture in schools. On the other hand, in the schools endowed with the high-level LO culture, teachers were less likely to receive technological advice from colleagues with whom they exchange pedagogical advice in a reciprocal way. That is, we found that LO culture appear to push the boundaries of conventional give-and-take exchanges by encouraging teachers to contact other colleagues for technological ASRs with whom they are not already in contact for pedagogical ASRs. Besides, teachers who are equally sought out for both technological and pedagogical ASRs were more likely to occupy a central position on advice networks in schools with the high-level LO culture. To put differently, the popularity of teachers who provide both technological and pedagogical ASRs to equal number of colleagues increases in schools where much more teachers perceive the high-level LO culture on average. The teachers who are asked for pedagogical advice by twice as many colleagues as technological advice were less likely to occupy a central position on advice networks in schools with the high-level LO culture. On the contrary, the teachers who are asked for technological advice by twice as many colleagues as pedagogical advice, so to say tech-savvy teachers, were more likely to occupy a central position on advice networks, but irrespective of the perceived LO culture in schools. These findings, coupled with the previous finding, imply that LO culture appears to mitigate the popularity of pedagogical advice givers, while technological advice-givers are already more popular than others to be sought out for ASRs in general. At last, it was found that the two teachers who are specifically sought out for technological advice by the same group of colleagues were more likely to give or receive, i.e. one-sided, pedagogical advice from each other in general. In other words, popular tech-savvy teachers are more likely to collaborate with each other, irrespective of the school's LO culture.

DISCUSSION

Theme 1: The Reciprocal Relationship between School Principal's TL Practices and School's LO culture

The findings of the latent class analysis (LCA) in the first study revealed that nearly half of Turkish school principals (55%) are statistically clustered into the high-level TL profile with a high level of performing

TL practices composed by all ISTE-A (2009) standards. Whereas, the rest of Turkish school principals (45%) expressed relatively a low level of engagement with ISTE-A standards and, thus, fell under the low-level TL profile. The number and distribution ratios of TL profiles support the empirical findings of Samancıoğlu et al. (2015), who indicated that 66% of Turkish school principals can be classified into a high-level profile of TL practices, while the rest falls under the low-level profile.

Despite the immense investment in schools' ICT infrastructure, TMONE seems to have neglected professional development needs of Turkish school principals building their capacity to effectively manage technical and organisational change caused by the Fatih project (Görgülü, 2013; Şahin & Demir, 2015). Our results indicate that nearly one out of every two Turkish school principals performs relatively low-level TL practices. While the accountability for the success of the centrally planned Fatih project is mainly distributed down to local school capacities in practice (Tolu, 2014); underperformance of one-half Turkish school principals in the overall TL practices become even more challenging for the future of the project. Despite the millions of dollars spent on the Fatih project schools, the success of the entire project is at stake because many Turkish school principals recognise their own incompetence in knowledge and expertise to improve human force and technical capacity of these schools (Karataş & Sözcü, 2013). Under this circumstance, we share the same concern as İzmirli (2015), who noted that what undermines the success of the Fatih project is the poor leadership displayed by school principals, which inevitably leads teachers to undertake the responsibility of ICT integration on their own.

The results of the LCA also distinguished the least and most performed ISTE-A standards for each profile. As a result for both profiles, the "systemic improvement" standard was reported as the least performed ISTE-A standard by its four indicators: a) using ICT tools for data-driven assessment and decision making about the development of teachers and students, b) seeking strategic partners outside school for ICT integration implementations, and c) recruiting ICT-skilled teachers (ISTE-A, 2009). On the other hand, the "digital citizenship" standard - concerning ethical, safe and fair ICT use in schools - was found to be the most performed ISTE-A standard in both profiles. This finding mirrors the previous studies by Banoğlu (2011), Metcalf and LaFrance (2013), Yieng and Daud (2017), who found that the "digital citizenship" standard was mostly exercised by school principals. In addition, our finding as to the "systemic improvement" standard corroborates some previous studies by Ünal, Uzun and Karataş (2015), Şahin and Demir, (2015); but contradict the study of Yorulmaz and Can (2016), who found that Turkish school principals obtain the highest competence score in the systemic improvement standard.

There are several possible explanations for this inconsistency and the underperformance of school principals in the systemic improvement standard. One of the reasons for this may be that the systemic improvement standard suggests school principals to execute ICT-based data-driven performance assessment and evaluation. However, Turkey's first online performance track system, namely "Learning Analytics Platform", has recently brought to the agenda of TMONE in the "Vision 2023" document (TMONE, 2018). Second, this systemic improvement standard suggests school principals to take teachers' ICT skills into account for recruiting new staff. Yet, Turkish school principals are only authorised to take decisions on employment of short-term substitute teachers. Therefore, another reason for this may be due to highly centralized nature of the school employment policy in Turkey. Third, this standard suggests school principals to establish strategic partnerships with other organisations for ICT integration implementations. Again, yet, neither in plan nor in practice Turkish ICT policy encourages school principals to leverage strategic partnerships.

Despite the abovementioned legislative and policy constraints in performing the systemic improvement standard in Turkey, an important conclusion of the second study reported in chapter 3 revealed that school principals' TL practices in compliance with this standard are able to predict a higher level of LO culture. The emergence of this positive school culture is characterised by teachers' higher perception of "team learning", "shared vision" and "systems thinking" professional learning orientations. In more statistical terms, if a school principal reported one-unit increase in performing TL practices related to "systemic improvement" standard, teachers who work with that principal in the same school were two times more likely to perceive the high-profile LO culture in that school. Three indicators of this standard concern employment, strategic partnerships and data-driven decision making TL practices. Taking these indicators into consideration, our empirical findings are clearly in line with the study of Zhao and Frank (2003), which implicated that the most likely mechanism for effecting change in teacher development and social relations is the recruitment/selection of teachers equipped with ICT skills. Also, Lesisko and Place (2005) underline the importance of recruiting the most qualified teachers in the integration of ICT into schools settings. In line with our findings, Pautz and Sadera's (2017) found that school principals who are inclined to establish external partnerships with other organisations appeared to be more responsible for making holistic cultural change in schools. Similarly, our study shows that building such a holistic cultural change in schools is related to school principal's systemic improvement TL practices, which recognize the relevance of internal school culture to external links and influences, such as

involvement in national school networks, external ICT-related initiatives, or national competitions regarding ICT use in schools (Tearle, 2004). The results of the second study also reinforce the view of Davidson and Olson (2003), who indicated that ICT integration forced school principals across the schools to build strategic partnership relations with other organisations which in turn transformed the professional culture within their schools.

Indeed, it is surprising that the four ISTE-A standards - other than the systemic improvement- appeared not to contribute to LO culture in schools. One possible explanation for this lack is that the systemic improvement standard is tailored to sustain and create purposeful organisational change by performing managerial tasks in particular (e.g. staffing ICT-skilled new personnel, assessing and evaluating performance by digitalised data, leveraging partnerships with other organisations). Yet, the other four ISTE-A standards are more directly engaged to the promotion of ICT-enriched pedagogical innovations in classroom environment (Richardson et al., 2012). Therefore, we can interpret that the systemic improvement standard has more to do with the establishment of a positive school culture at school level than with pedagogical innovations in classrooms.

As for structural factors, numerous previous studies have drawn on the integrity of sociocultural (leadership, school culture, professional interactions) and structural (availability of ICT infrastructure and internal ICT support) factors in ICT integration implementations (Flanagan & Jacobsen, 2003; Tondeur et al., 2008; Vanderlinde, van Braak, & Dexter, 2012). One of the significant results emerging from this study is that the ICT infrastructure constructed by the Fatih project pave the way for school principals to perform a high level of TL practices by all ISTE-A (2009) standards. That is, the principals of the schools with ICT-enriched classrooms supplied by Fatih project are more likely to perform effective TL practices by all ISTE-A standards. To exemplify the magnitude of its predictive power in statistical terms, school principals who manage a Fatih project school are almost twenty-six times more likely to perform a high level of TL practices, compared to non-project schools' principals. This result provides a robust empirical evidence to support Anderson and Dexter's (2005, p. 56) model of TL which delineates the interplay between infrastructure and TL practices in schools. Also, this result corroborates another study of Dexter (2011), who indicates that when teachers' access to ICT infrastructure is taken granted as a necessary prerequisite, though not adequate by itself, professional development of teachers through team-based TL practices are facilitated in schools.

Together with ICT infrastructure, in the first study, we control for the effect of individual factors on school principal's TL practices, such as principal's gender, age, computer and internet usage frequency. In the second study, teacher's gender, age, years of experience are involved in the analysis as control variables. Our findings revealed that school principals who use internet for a longer duration are more likely to perform a higher level of TL practices. In more statistical terms, 2-3 hours increase in a school principal's internet usage duration results in 56% increase in the logs odds of performing a high level of TL practices. Similarly, Banoğlu (2012) showed that school principals who performed higher levels of TL practice use internet more frequently. Unlike the internet usage, school principal's computer usage did not prove to be a predictor of TL practices. In the third study, the findings with regard to teacher's individual characteristics show that elderly teachers are more likely than their younger colleagues to perceive a higher level of LO culture by their five professional learning orientations. This result is congruent with the findings of Celep, Konaklı, and Recepoğlu, (2011), and Recepoğlu (2013), who found that the more teachers get older, the more they state positive opinion about school's LO culture. However, our finding is inconsistent with Mulford et al. (2004), who indicate that teacher's age has nothing to do with their perception of LO culture.

Another important conclusion to emerge from this study is that we elicited two significant factors by which TL practices and LO culture interplay, i.e. "systemic improvement" oriented TL practices and teachers "team learning" professional learning orientation. When teachers recognize the value of ICT in contributing to their creative thinking and problem solving skills, a newly emerging collaborative workplace culture can trigger drastic changes in teacher's professional learning (Kennewell, Parkinson, & Tanner, 2000). Our findings about the "team learning" orientation strengthen this view, extending our knowledge of team-based working and learning dispositions related to TL practices (Dexter, 2011). This conclusion is in line with Dexter's (2011) study which underlines the importance of team-based working practices in the integration of ICT into school settings from the distributive leadership perspective (Spillane, 2005a). However in this study, we set a more direct focus on the overall change in school's LO culture rather than the distributive leadership relations, based on the LO theory (Senge, 1990; Senge et al, 2000). Because in the third study it is found that the "team learning" professional orientation fluctuates in accordance with other four professional learning orientations as part of school's overall LO culture. Coupled with the results from the second study, we suggest that teachers' team-based learning and working practices may have an influence on school principal's TL practices, but this professional

learning orientation is also related to other professional learning orientations as assumed by Senge (1990). For instance, in the second study we show that the “shared vision” and “team learning” professional learning orientations are closely interrelated and unique to support other professional learning orientations in both low-level and high-level LO profiles. This finding corroborates the findings of previous studies by Confessore and Kops (1998), Nissila (2005) as well as Uibu, Kaseorg, and Kink (2016), which indicate that professional learning orientations all in connection encourage teachers to follow a common path toward sharing a school vision, which in turn allows teachers to collaborate with their peers. Marking school principals’ TL practices as the subject of inquiry in the second study, our findings shows that managerial extensions of the broader idea of ICT integration in schools may enable, limit or alter existing organizational structures, social relations, cultural beliefs and learning experiences in schools (Cakir ,2012; Celep, Konaklı & Recepoğlu, 2011; Gratham, 2009). In other words, this study implies that school principals’ TL practices do not only supports teachers' effort to reach some pre-planned instructional ends, but also cultivates the whole school community with genuine cultural values about the learning itself (MacGilchrist, Myers, & Reed, 2004).

To conclude, the main argument put forward in this dissertation evolves around the idea that TL practices and LO culture can be viewed as both dependent and independent variables in a reciprocal relationship between the presence of supportive leadership practices and positive organisational culture in schools (Davidson & Olson, 2003; Dexter, 2011; Law, Yuen & Fox, 2011). As such, our findings provide empirical evidence to support the pioneering roles of the “systemic improvement” orientation in school principal’s TL practices and the “team learning” orientation in teacher’s professional learning in breaking new ground for the integration of ICT into schools. Further research can address this relationship through multiple data sources (e.g., from the perspective of students, teachers, school principals and district authorities), using a mixed research design based on both quantitative and qualitative data.

Theme 2: Indicators of ICT Coordinator’s Professional Self-Efficacy

Coupled with school principals, ICT coordinators take on a pivotal role when it comes to providing internal ICT support to teachers on the integration of educational technologies into their repertoire of teaching and learning strategies (Araiz, 2018; Lai & Pratt, 2004; Lesisko, 2005; Lesisko & Place, 2005). The first and second study address the reciprocal relationship between school principal’s TL practices

and school's LO culture. In the third study, concerning the quality of internal ICT support, we present a research instrument that assesses professional self-efficacy levels of Turkish ICT coordinators.

An ICT coordinator's self-efficacy can be described as one's self-confidence to use ICT for instructional purpose (Krumsvik, 2014). In order to determine competence fields of an ICT coordinator's professional self-efficacy, we drawn on the performance indicators featured in the Professional Competence Framework for ICT Teacher (TMONE, 2008). In this official Turkish framework, a list of performance indicators required to define ICT coordinator's professional self-efficacy was categorised under seven competence fields, such as 1) instructional design, 2) using ICT-related concepts properly, 3) measurement and evaluation tools, 4) hardware and software equipment, 5) multimedia applications, 6) instructional software, and 7) safe and ethical ICT use competence. Given the low number of in-service ICT coordinators available in the overall research population (i.e. only 53 ICT coordinators in an urban district with around half million population), we collected data from 257 pre-service ICT coordinators to carry out reliability and validity analysis of the developed research instrument. Once we conducted reliability and validity studies with 257 pre-service ICT coordinators, we administered it to 53 in-service ICT coordinators from the main research population.

Before discussing the results from this analysis, we would like to mention an important point on the accessibility of in-service ICT coordinators in Turkish schools. While in the third study we set out to construct a new research instrument to measure the quality of internal ICT support, such a low number of in-service ICT coordinators raises a further concern about the availability of that support in Turkish public schools at the outset. When we made a comparative review of ICT coordinators' employment status, we came across a great variety of national ICT policies. For example, in some countries like the Republic of Lithuania, ICT coordinators have never been officially employed in Lithuanian schools (Markauskaite, 2003). While in another case, only 31% of U.S. public schools have a full-time ICT coordinator on faculty. In one of the Western European countries, the national ICT policy of France stipulated that all lower and upper secondary schools should have at least one ICT coordinator (Regnier, 2003). As for Turkey, 60% of Turkish primary school students, 70% of Turkish middle school students, and 50% of Turkish secondary school students were receiving education in a school with an ICT coordinator (European Commission Final Report, 2013). Our study show that the ratio of K-12 schools with an incumbent ICT coordinator equals to 54% in the surveyed districts. What makes this ratio even more challenging is that inadequate access to the internal ICT support in Turkish school can constitute

an impediment to the effectiveness of TL practices executed by Turkish school principals (cf. Banoğlu, 2011). Therefore, in this study we underline the fact that there is a special need for the employment of more ICT coordinators in Turkish public schools (Demirer & Sak, 2015; Eren & Uluuysal, 2012; Karal & Timuçin, 2010).

The findings obtained from this study show that in-service ICT teachers perceive themselves to be fairly efficient in "safe and ethical ICT use" competence. This finding is consistent with the study of Dursun (2013), who indicated that ICT coordinators evaluated their efficacy level as "very high" in ethical ICT use. This result is encouraging since it means that ICT coordinators perceive themselves competent to deal with the most serious challenges of today's digital age, such as security issues, privacy problems, internet vulnerability, unauthorised access attempts and so on (LaFee, 2005). Still, it is arguable whether other school actors are ready to benefit from this professional competence of ICT coordinators. Because Kuru and Yılmaz (2018) have recently found that Turkish teachers rarely talk with ICT coordinators about ethical dimensions of ICT use. According to Kuru and Yılmaz, Turkish teachers appeared much more interested in contacting ICT coordinators for receiving technical help about multimedia applications rather than talking about some general issues of ICT using. Yet, again, the results of our study indicate that ICT coordinators rate the lowest self-efficacy score in this competence, i.e. using multimedia applications. As Dursun et al. (2013) point out that Turkish ICT coordinators are mostly expected to solve the technical problems likely to be faced by other teachers while using multimedia applications. Thus, our finding as to ICT coordinators' inadequcy feeling about this competence may raise a concern about the quality of internal ICT support in Turkish schools. According to Eren and Uysal (2012), shortcomings of professional development opportunities for Turkish pre-service and in-service ICT coordinators may lead to this feeling of inadequacy. In addition, again according to Eren and Uysal, it is known that Turkish ICT coordinators always complain about having no time for their professional development. This may impede Turkish ICT coordinators to feel themselves inadequate about the use of multimedia applications. Durak and Seferoğlu (2017) demonstrate that such a feeling of inadequacy is one of the most important cause for professional burnout of Turkish ICT coordinators. To overcome those individual and organisational problems, our findings strengthen the view of Yıldız, Sarıtepeci and Seferoğlu (2013), who suggest that ICT coordinators should develop themselves regarding the effective use of multimedia applications by allocating enough time and source for their professional development.

The analysis of ICT coordinators' demographics has extended our knowledge of the relevance of gender differences to their ICT self-efficacy level. More concretely, we found that female ICT coordinators have higher professional self-efficacy as to instructional design, hardware and software, measurement and evaluation, safe and ethical ICT use competency fields than their male counterparts. There are numerous studies which could not find any gender difference associated with ICT self-efficacy (Pamuk & Peker, Scherer & Siddiq, 2015; Teo, 2008). Also, the findings of many other studies (Dundell & Haag, 2002; Gudmundsdottir & Hatlevik, 2017; Sieverding & Koch, 2009) concluded that males report higher levels of ICT self-efficacy compared with females. However, as far as we are concerned, this result had not previously been described in favour of females before our study. Given the lack of previous studies supporting our finding, it is difficult to explain this result. A further study with more focus on possible mediators of the influence of gender demographics on ICT coordinators' self-efficacy is therefore suggested.

A possible direction for future research could be to compare male and female ICT coordinators' educational beliefs about the value of using ICT in different ways. Because Tondeur et al. (2008a) show that the gender difference might disappear when teachers used ICT as a learning tool, or for developing their ICT skills. In addition, Tondeur et al. (2008b) indicate that a higher percentage of male population in a school could partially explain the use of ICT in classrooms when teachers' perception of internal ICT support is controlled for. Therefore, future research could involve this school characteristic for the examination of the gender difference.

Theme 3: Interrelatedness of Professional Interactions on Technological and Pedagogical ASRs

In order to examine the relationship between professional interactions among school actors and school's LO culture, we compared professional interaction networks in two groups of schools where teachers perceived the highest and lowest LO culture by the five professional learning orientations (i.e. team learning, shared vision, systems thinking, personal mastery and mental models). Based on the school averages of teachers' perception of these professional learning orientations, we grouped schools as the 'best' and 'worst' schools with LO culture. Next, we compared professional collaboration networks of teachers between these two groups. For this purpose, in the fourth study, we examine advice-seeking relationships (ASRs) by which teachers solicit advice from colleagues on technological and pedagogical issues. While doing so, we also control for certain individual teacher characteristics and relational

differences between them (e.g. age, gender, departmental and administrative position differences between school actors).

Consistent with previous research that has demonstrated that multilevel factors – individual (micro-level), relational (meso-level), and organisational (macro-level) – may be associated with ASRs (Frank & Zhao, 2005; Moolenaar et al., 2014a), our findings show that teachers' experience, gender, administrative position at micro-level, similarity of these micro-level factors between teachers at meso-level, and the average teacher experience, the perception of LO culture at the macro-level, are related to ASRs regarding technological and pedagogical issues. Technological issues concern the use of ICT for instructional purposes, while the subject of pedagogical issues refer to the repertoire of teaching strategies in particular. In line with Moolenaar's (2010) findings, we revealed that experienced teachers are more likely to occupy a central position (i.e. popularity) in a pedagogical advice networks. Besides, in our study we found that teachers with similar years of experience had more tendency to engage in technological and pedagogical ASRs. This result corroborates the view of McPherson et al. (2001), who remark that social relationships appear, to a greater extent, to be homophilous concerning teaching experience. Besides, some other studies concluded that teachers have more tendency to contact each other when they share a common past experience (Coburn & Russell, 2008; Moolenaar et al., 2014a). Yet, our research came up with a contrasting conclusion, showing that the more years of experience teachers share, the less they establish reciprocal ASRs on pedagogical issues. In other words, pedagogical ASRs between novice and experienced teachers are found to be more likely than those established within only novice teachers or experienced teachers in general. This finding partly supports the finding of Geeraerts et al. (2017), who showed that the youngest teachers are the most preferred school actors to collaborate with by experienced teachers. One possible explanation for this could be that teachers who have a lot of experience in school, might consider themselves as expert teachers about pedagogical issues, and as such, find it unnecessary to establish mutually reinforcing ASRs around pedagogical issues with other experienced teachers in the same school context. Or, when the average experience of the teacher community decreased, teachers may be more relaxed about seeking pedagogical and technological advice from other similarly less experienced teachers.

As we controlled for the influence of gender, the results drawn from probabilistic SNA show that male teachers occupy a more central position, such that they are more likely to provide technical and pedagogical advice than their female counterparts. Although this finding is inconsistent with Moolenaar's

(2010) study, which concluded in favour of female teachers in Dutch elementary schools, a possible explanation for this contradiction is that our study covers all K-12 school level. A common feature of elementary and middle schools is the uneven gender distribution among teachers which is skewed towards female demographic (Pont, Nusche, & Moorman, 2008). In other words, female teacher population outnumbers the male teacher population especially in elementary and middle school levels. This uneven gender distribution can be a reason why female teachers are more likely to occupy a central position on advice networks in these school levels, but not in the overall K-12 level as we found. At last, it is also possible that this difference could also be the result of distinctive cultural contexts in Dutch and Turkish schools.

As for teachers' departmental affiliations, the findings we reached in the fourth study reveals that reciprocal ASRs are more likely to emerge between teachers from different departments. Indeed, there are controversial findings about the relevance of departmental positions to teacher collaboration in the literature. For example, Spillane, Hopkins and Sweet (2015) as well as Penuel et al. (2010) disclosed that teachers teaching the same grade level are more likely to interact with each other than with colleagues teaching different grade levels. Whereas, Brennecke and Rank (2016) showed that members of an organisational community with multiple departmental affiliations have more tendency to seek advice from colleagues in different departments. Another similar finding to our study was reported by Hiltz (2011), in which reciprocal ASRs on technological issues were far more observed between teachers who work in different departments than those in the same department. Additionally, we found that holding a departmental leadership position is not related to an increase or decrease in the likelihood of advice seeking and/or providing. Spillane and Hopkins (2013) conversely concluded that departmental headship plays a crucial role in the formation of ASRs in U.S. elementary schools. However, it is a worrying finding for Turkish schools because it confirms previous studies (Göksoy & Yenipınar, 2015), which point out that departmental meetings, routines and positions are well-intentioned but il-planned and far from being effective for teacher learning in Turkish schools (Demirtaş et al, 2008). For this dissertation, unfortunately, we conclude that neither departmental assignment nor, if any, leadership position encourage Turkish teachers to establish ASRs with colleagues from the same department. One explanation for this cross-departmental tendency may be that physical proximity of the staff rooms could facilitate or hamper cross-departmental ASRs between teachers teaching the same or different subject-fields (Spillane, 2005b; Spillane, Kim & Frank, 2012; Spillane, Shirrel, & Sweet,

2017). In our case, Turkish schools have no separate staff rooms for each department but one single staff room in which all teachers from different departments and grade-levels come together. Thus, sharing the same staff room may pave the way for Turkish teachers to collaborate with colleagues from different departments to some extent.

A number of studies concluded that school principals, vice-principals and head teachers are natural advice-providers because of their formal leadership positions, though, their centrality can vary to a great extent (Moolenaar, Daly & Sleegers, 2010). To verify this claim in our study, we controlled for a teacher's administrative position, coded as principal or vice-principal. As a result, we found that teachers' administrative superiority could encourage them to provide technological and pedagogical advice to their subordinates. However, they did not display a similar tendency while seeking technological and pedagogical ASRs from their subordinates. Nevertheless, one-sided pedagogical ASRs were found more likely to occur between superiors and subordinates as teachers tended to head for school principals more than vice-principals, and much more than other teachers while seeking pedagogical ASRs. This means that school administrators (principals and vice-principals) very rarely seek advice from teachers but still they are sought out for pedagogical ASRs by the teachers. Despite the prevalence of one-sided interactions, reciprocal interactions between superiors and subordinates were not predicted in general. Instead, teacher-to-teacher and vice-principal-to-vice-principal ASRs were found to be more likely in a reciprocal way. Coupled with our previous findings, we can conclude that teachers tend to engage in reciprocal ASRs with those outside department and without an administrative position. This result underlines in bold the importance of informal professional interactions against formal ones which is structured by teachers' departmental affiliations (Frank, 2009).

The present dissertation adds to the research literature showing that formally structured professional relations are more likely to occur in a one-sided way (e.g teacher-to-principal) or at all (e.g. head teacher-to-teacher); whereas the more qualified, reciprocal interactions come up with either cross-departmental or cross-positional ASRs. Therefore, we echo the argument that *"although important, formal structure is not everything. A distributed perspective allows for the possibility that individuals without a formally designated leadership position take on leadership work."* (Spillane, 2005, p.390). Coupled with our previous results, we provided empirical evidence that school's LO culture contributed to the likelihood of reciprocal pedagogical ASRs. Hence, our study regard LO culture as a proxy for a positive school culture which is associated with professional interactions among school actors, alongside the

commitment to shared school values (Frank & Zhao, 2005) and innovative school climate (Moolenaar et al., 2014b). An important conclusion to emerge from this dissertation is that if a school's cultural context promotes higher level of LO culture, this positive school culture intensifies mutual teacher collaboration by pedagogical ASRs. Likewise, Frank (2009) asserts that teachers who identify themselves with the school collective can override relationships with specific others. By this means, school's cultural context gives a base for solidarity among teachers. Teacher collaboration may arise in appropriate school contexts in which sustained collaborative efforts come to the forefront to solve organisational problems and build knowledge together (Hakkaraienen, Palonen, Paavola & Lehtinen, 2004). In further investigations, it might be possible to use a different sociocultural factor, such as collegial friendship ties, in association with teachers' professional interactions. Then, research questions that could be ask include whether social and professional relations interplay in the context of ICT integration implementation. Future research on this topic is therefore recommended.

To conclude, in this study we interrogated how principal leadership, school culture and professional interactions provide a cornerstone for the sociocultural transformation caused by ICT integration into schools. First, we disclosed the "team learning" professional learning orientation as a condition of effective TL practices. Next, we set the "systemic improvement" oriented TL practices as a leverage for building a positive school culture, i.e. LO culture. Third, we investigated how and why ICT coordinators' professional self-efficacy is critical to the quality of internal ICT support in schools by developing an original research instrument. At last, we elicited the multiple determinants of teachers' professional interactions in relation with school's LO culture to better understand by which interaction patterns teachers seek technological and pedagogical ASRs from colleagues.

LIMITATIONS AND IMPLICATIONS

Several limitations of the present dissertation need to be considered. In this section, we also provide some implications for future research, educational policy makers and school principals. First of all, the generalizability of our findings beyond the Turkish context is subject to certain limitations due to Fatih project. For example, the availability of ICT infrastructure in schools was measured by the provision of interactive smart boards, personal tablet PCs and the high speed internet connection in all classrooms which are installed by the Fatih project. However, other ICT facilities which had previously been installed in computer classrooms were disregarded in this study. This is an important contextual limitation of the present work. Another limitation is that the instalment of ICT-enriched classrooms with interactive smart

boards and speed internet connection by itself does not take for granted the actual use of this infrastructure in schools. Neither the delivery of personal tablet PCs to students makes sure that they are actively in use. Therefore, this study attends to the availability of ICT infrastructure in Turkish schools, but not the actual use of these smart boards and tablet PCs by teachers and students. This limitation means that the findings concerning ICT infrastructure need to be interpreted cautiously.

As for the methodological limitations of the first and second studies, even though multilevel analyses were conducted with an adequate sample size in these studies, the obtained results are representative for a single educational district in Turkey. Further national and international studies are needed to carry out the same research design through multi-group LCA procedures in a variety of cultural contexts. The results from a representative survey of one district may not be applicable to others as previous research has suggested that various district characteristics may be related to professional development of teachers and school principals, such as district size and financial resources allocated to professional development activities (Bidwell & Kasarda, 1975; Sincar, 2013). To overcome this methodological constraint, the findings of these studies is to be replicated by collecting data from multiple districts and using the multi-group LCA which allows to test the homogeneity of LO and TL profiles across districts. Another methodological limitation of these studies is that the measures of school principals' TL practices were assessed based on self-report questionnaire data. However, several previous research noted that teachers and principals vary in their perceptions of TL practices (Devos et al., 2013; Şahin & Demir, 2015). Thus, future research should consider using a cross-validation by also examining teachers' perception of TL practices.

A few caveats need to be noted regarding the third study as well. First, perceived self-efficacy is concerned with respondents' beliefs in their capabilities. Thus, there could be an inherent inclination for respondents to underrate or overrate themselves as a matter of fact. Another limitation of this is that data collected for the scale development study came from pre-service ICT coordinators. However, the follow-up survey was completed by in-service ICT coordinators. Therefore, one source of weakness in the third study lies in the experience difference between pre-service and in-service ICT coordinators, which could have produced biased results.

In the fourth study, only limited number of micro, meso and macro level factors were included in social network analysis (SNA). For instance, the networking positions of ICT coordinators were not examined in this study since there were only four ICT coordinators in our research population. Nevertheless, we

acknowledge that ICT coordinators could be the most critical network actor to be nominated as an advice-provider on the use of ICT. This is a main limitation of the fourth study and it should be examined in future research. Besides, given the convergence issue confronted in probabilistic SNA applications, the second stage of SNA is limited with meta-analysis of the exponential random graph models (ERGM), which were generated from 6 convergent advice networks in 6 schools.

In light of evidence found in this study, we can draw some implications for educational policy makers and school principals. Based on the evidence from the first, second and fourth studies, we suggest that school principals should promote team-based learning activities and informal professional interactions among teachers by building a positive school culture. This conclusion is broadly in line with the findings of Dexter (2011), who found that effective TL practices enable team-based decision making and collaborative sense-making among teachers. Therefore, we implicate that school principals should form and work with teacher teams by maintaining a collective focus on the “team learning” professional learning professional learning orientation. While building teacher teams, school principals also should be aware of individual and relational teacher characteristics, such as cross-departmental and intergenerational collaborations. Based on this finding, we suggest that school principals should make a point of forming teacher teams with members from different subject-field and grade-level teachers.

Besides, the research instrument developed in the third study may be also interesting for Turkish educational authorities. The educational policy makers can benefit from this instrument to evaluate Turkish ICT coordinators’ professional self-efficacy in public K-12 schools in Turkey. Based on the measures obtained from its seven dimensions, educational policy makers can determine which professional competencies of Turkish ICT coordinators need improvement so that they can address the gaps between pre-service and in-service workforce requirements of ICT coordinators. By developing professional capacity of ICT coordinators, educational policy makers would not only have improved the quality of internal ICT support in Turkish schools, but also would have strengthened the density of informal professional interactions among teachers. Because the results from the fourth study show that tech-savvy teachers to whom other teachers turn to for seeking technological advice are more likely to occupy a central position in providing pedagogical advice to colleagues. This conclusion underlines the importance of ICT coordinators as informal educational leaders in Turkish schools. Given their technical expertise, it can be easily presumed that most of ICT coordinators are the most preferred ICT support

staff in schools. The present study extends our knowledge of how ICT coordinators, or other teachers with technological expertise, may be advice-providers on pedagogical issues as well.

In the second study, we conclude that school principals' "systemic improvement" oriented TL practices are significant predictors of the higher level of perceived LO culture in Turkish schools. Based on this important conclusion, we suggest three broad policy implications. First, district-level educational authorities can organize various networking activities open to public schools, educational technology companies, and universities. By these networking activities, they can foster strategic partnership relations between public schools and other organisations, which may encourage school principals to create a working milieu conducive to the promotion of school's LO culture. Second, we suggest that national educational authorities should make amendments to the State Staff Act in a way that empowers school principals to recruit new ICT-skilled teachers on staff. Third, as committed in the "*Turkey's Education Vision 2023"* (TOMNE, 2008), the "Learning Analytics Platform" (LAP) should be put into action as soon as possible because the school principals who track teachers and students' performance based on digitalised multiple data sources were found to be more influential to the promotion of school's LO culture as a whole. Establishment of such an online platform could provide a ground for necessary legislative changes to carry out data-driven decision making process in Turkish schools. By this means, we suggest that all educational authorities and school principals could monitor the progress of the Fatih project in district, province, region and country. This online platform could also be useful to activate interactions between in-school and out-school educational stakeholders, such as parents, district authorities teachers and school principals.

While planning the implementation of ICT integration into schools settings, educational policy makers should allocate enough time and financial resource to the sociocultural transformation of workplace environment in Turkish schools. The school principals who manage Fatih project schools and other school principals could be brought together in monthly meetings to activate the experience sharing and dissemination of good TL practices within the district. These monthly meetings could be held through virtual conferences, social media groups and educational portals, which could support a broader internet usage among school principals.

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SAMENVATTING (SUMMARY IN FLEMISH)

Verdere integratie van Informatie- en Communicatietechnologieën (ICT) in onderwijsprocessen heeft geleid tot onderwijsveranderingen op scholen. Naast de pedagogisch innovatieve invloed van ICT op de onderwijsstrategieën van leraren, heeft ICT-integratie ook geleid tot belangrijke sociaal-culturele transformaties in organisatorische relaties in de schoolomgeving. In dit proefschrift worden deze sociaal-culturele veranderingen - die hebben plaatsgevonden door ICT-integratie - in openbare scholen in Turkije bestudeerd. Om dit overkoepelende doel te realiseren worden meervoudige relaties bestudeerd tussen *ICT-leiderschapspraktijken van schoolleiders* (school principals' technology leadership practices - TL); *lerende schoolcultuur kenmerken* (schools' learning organisation culture - LO); en *professionele interacties* tussen de schoolleider, assistent-schoolleiders, ICT-coördinatoren en leraren. Tijdens de verschillende studies wordt statistisch gecontroleerd voor aanwezige en beschikbare ICT-infrastructuur als een structurele conditie voor succesvolle ICT-integratie, naast demografische kenmerken van leraren en schoolleiders. Voor de structurele conditie die betrekking heeft op de kwaliteit van de schoolinterne ICT-ondersteuning werd een meetinstrument ontwikkeld dat doelmatigheidsbeleving van Turkse ICT-coördinatoren meet.

ICT-leiderschapspraktijken van schoolleiders (TL) zijn gespecificeerd aan de hand van het gekende ISTE-A raamwerk. Dit raamwerk is ontwikkeld door de 'International Society for Technology in Education for Adminstrators' en beschrijft ICT-competenties voor schoolleiders en andere leidinggevenden in onderwijs. Volgende competenties worden naar voren geschoven in dit raamwerk: 'visionary leadership', 'digital-age learning culture', 'excellence in professional practices', 'systematic improvement', en 'digitial citizinship'. *Lerende schoolcultuur* (LO) wordt gedefinieerd als een positieve schoolcultuur die bijdraagt aan de professionele ontwikkeling van leraren. Lerende schoolcultuur kenmerken worden daarbij gezien als proxy voor deze positieve schoolcultuur. Vijf lerende schoolcultuur kenmerken worden onderscheiden op basis van de literatuur: 'team learning', 'shared vision', 'systems thinking', 'personal mastery', en 'mental models'. *Professionele interacties* worden bestudeerd door te kijken naar professionele ondersteuningsrelaties tussen leden van het schoolteam (advice-seeking relationships - ASRs) m.b.t. het geven van zowel pedagogisch advies als ICT-specifiek advies. Bij de ontwikkeling van de meetinstrumenten in dit proefschrift werd rekening gehouden met de specifiek Turkse context, i.c. met het competentieraamwerk 'National Competency Framework for ICT coordinators' ontwikkeld door het Turks Ministerie van Nationaal Onderwijs.

Het doctoraatsonderzoek is gebaseerd op vier empirische studies waarover elk apart in een hoofdstuk wordt gerapporteerd. Het eerste empirische hoofdstuk onderzoekt de voorspellende waarde van lerende schoolcultuur kenmerken (LO) - gepercipieerd door leraren -, op ICT-leiderschapspraktijken van schoolleiders (TL). In deze studie werd data verzameld via vragenlijsten bij 58 schoolleiders en 1105 leraren. Twee onderzoeksvragen staan centraal bij de data-analyse: 1) Welke profielen kunnen onderscheiden worden bij schoolleiders op basis van hun ICT-leiderschapspraktijken (TL); en 2) In hoeverre kunnen deze ontwikkelde ICT-leiderschapsprofielen voorspeld worden aan de hand van demografische kenmerken van schoolleiders, computer- en internet gebruik en aanwezige ICT-infrastructuur, en lerende schoolcultuur kenmerken (LO)? Voor het beantwoorden van de eerste onderzoeksvraag werd gebruik gemaakt van 'latent class analysis (LCA)' om schoolleiders hun ICT-leiderschapspraktijken te categoriseren in profielen. Binnen ieder gevonden profiel worden schoolleiders geplaatst die gelijkaardig scoren op de ISTE-A standaarden of ICT-competenties voor schoolleiders. In deze studie werd een hoog en een laag ICT-leiderschapspraktijken- profiel onderscheiden. Resultaten tonen dat 55% van de schoolleiders geclusterd kan worden in het hoog profiel en dat 45% van de schoolleiders behoort tot het lage profiel. Binnen het hoge profiel worden op alle ISTE-A standaarden of ICT-competenties hoog gescoord. Antwoorden en resultaten voor de tweede onderzoeksvraag werden geanalyseerd aan de hand van logistische regressieanalyse en tonen aan dat Turkse schoolleiders hoog scoren op de ICT-leiderschapspraktijken als hun scholen behoren tot de ICT vernieuwende scholen uit het Fatih-project, als ze vaker de computer en internet gebruik, maar ook als ze schoolleider zijn in een school waarbij de leraren de school percipiëren als een lerende schoolorganisatie (LO).

De tweede empirische studie maakt gebruik van dezelfde dataverzameling als de eerste studie (nl. vragenlijstgegevens van 58 schoolleiders en 1105 leraren). Dit hoofdstuk onderzoekt de voorspellende waarde van ICT-leiderschapspraktijken van schoolleiders (TL) op door leraren gepercipieerde lerende schoolcultuur kenmerken (LO). In deze studie wordt gecontroleerd voor geslacht, leeftijd, leservaring, en onderwijsniveau. In deze studie worden dus de kernvariabelen uit de eerste studie gewisseld. Twee centrale onderzoeksvragen worden gesteld: 1) Welke profielen kunnen onderscheiden worden op basis van door leraren gepercipieerde lerende schoolcultuur kenmerken (LO)?; en 2) In hoeverre kunnen deze ontwikkelde lerende schoolcultuurprofielen (LO) voorspeld worden aan de hand van ICT-leiderschapspraktijken van schoolleiders (TL), gender, leeftijd, leservaring en onderwijsniveau? De

resultaten tonen aan dat gegevens van leraren op de vijf lerende schoolcultuur kenmerken kunnen geclusterd worden in drie profielen: een hoog, een gemiddeld, en een laag profiel. De resultaten voor de tweede onderzoeksvraag werden geanalyseerd door middel van logistische regressieanalyse. De resultaten tonen aan dat leraren de lerende schoolcultuur kenmerken hoger inschatten als hun schoolleider hoger scoort op de 'systematic improvement' ICT-leiderschapspraktijk. De resultaten tonen ook aan dat oudere leraren en leraren die lesgegeven in middenscholen eerder in het hoog profiel dan in het gemiddeld profiel zullen scoren.

De derde studie brengt verslag uit van een onderzoek naar schaalontwikkeling. In deze studie wordt een valide en betrouwbaar meetinstrument ontwikkeld die de professionele doelmatigheidsbeleving van ICT-coördinatoren in kaart kan brengen. Om dit meetinstrument te ontwikkelen werd vooreerst een item-pool ontwikkeld van 53 items op basis van beschikbare Turkse referentiekaders, i.c. het competentieraamwerk 'National Competency Framework for ICT coordinators' ontwikkeld door het Turks Ministerie van Nationaal Onderwijs. In een volgende stap werd de kwaliteit van deze itempool getoetst bij vier onderzoeksexperts werkzaam aan drie Turkse faculteiten die ICT-coördinatoren opleiden. Op basis van deze input sneuvelden 8 items. Vervolgens werd data verzameld bij 190 pre-service ICT-leraren om het meetinstrument te ontwikkelen. EFA (i.c. principale componentenanalyse) en CFA-procedures werden doorlopen. De resultaten van de EFA beschrijven een meetinstrument bestaande uit 34 items en 7 dimensies die 65,90% van de totale variantie kon verklaren. De daaropvolgende CFA bevestigt deze structuur waarbij 1 item werd verwijderd. Het finaal ontwikkelde meetinstrument bestaat dus uit 33 items en 7 dimensies, waarbij goede Alpha-maten werden berekend. De 7 dimensies van het meetinstrument zijn terug te brengen tot de competentiegebieden omschreven door het Turks Ministerie van Nationaal Onderwijs (TMONE): 'mastery of instructional design', 'using ICT related concepts properly', 'measurement and evaluation tools', 'hardware and software equipment', 'multimedia applications', 'instructional software', en 'safe and ethical ICT use'. Tot slot werd het meetinstrument ook afgenomen - in een retest desing - bij 67 pre-service ICT-coördinatoren en 53 in-service ICT-coördinatoren. Resultaten van de beschrijvende statistieken en variantieanalyses tonen aan dat vrouwelijke ICT-coördinatoren hoger scoren op de dimensies 'instructional design', 'measurement and evaluation tools', 'hardware and software equipment', en 'safe and ethical ICT use' dan hun mannelijke collega's.

In het vierde en het laatste empirisch onderzoek werd gekeken naar professionele ondersteuningsrelaties tussen leden van het schoolteam (advice-seeking relationships - ASRs) m.b.t. het geven van zowel pedagogisch advies als ICT-specifiek advies. In het onderzoekdesign werd gebruik gemaakt van variabelen op individueel (micro-niveau: geslacht, leeftijd, jaren onderwijservaring, leiderschapsrol), relationele variabelen tussen leraren (meso-niveau: verschil in geslacht, leeftijdsverschil, verschil in jaren onderwijservaring, verschil in positie binnen het team), en organisatorische variabelen (marco-niveau gemiddelde onderwijservaring van leraren op school, gepercipieerde lerende schoolcultuur kenmerken (LO)). Ook werd de samenhang bestudeerd tussen pedagogisch advies en ICT-specifiek advies. In deze vierde studie staan twee onderzoeksvragen centraal: 1) In welke mate voorspellen de variabelen op micro-, meso-, en macro-niveau (zie hierboven) de professionele ondersteuningsrelaties tussen leden van het schoolteam (advice-seeking relationships - ASRs) m.b.t. het geven van zowel pedagogisch advies als ICT-specifiek advies?; en 2) Welke structurele factoren beïnvloeden de verschillen tussen de ondersteuningsrelaties (ASRs) m.b.t. het geven van pedagogisch advies en ICT-specifiek advies in scholen die door leraren als hoog versus laag gepercipieerd worden op de dimensies van lerende schoolcultuur kenmerken (LO)? De verzamelde gegevens werden geanalyseerd met behulp van sociale netwerkanalyse, meer concreet via p2 en ERGM geavanceerde applicaties die nooit eerder in Turkije werden gebruikt. De bevindingen op de eerste onderzoeksvraag tonen aan dat mannelijke leraren aanzienlijk meer advies geven over technologische en pedagogische kwesties dan hun vrouwelijke collega's. Ook tonen de resultaten aan dat leraren met hetzelfde geslacht, leraren met eenzelfde aantal jaren ervaring, en leraren die hetzelfde vak geven; meer pedagogisch en ICT-specifiek advies aan elkaar zullen geven. Het onderzoek stelde vast dat ondersteuningsrelaties (ASRs) rond pedagogische kwesties vaker voorkomen bij leraren die een administratieve leiderschapspositie innemen en hun ‘ondergeschikten’. Ook komen deze ondersteuningsrelaties (ASRs) voor pedagogisch en ICT-specifiek advies meer voor bij leraren die tot eenzelfde leiderschapspositie behoren (bv. leraar naar leraar, adjunct-schoolleider naar adjunct-schoolleider). Een belangrijk resultaat van deze studie is dat wanneer leraren hun school hoog percipiëren op de lerende schoolcultuur kenmerken (LO), ze ook meer geneigd zijn om pedagogisch advies (ASRs) aan elkaar te geven. Dit patroon werd ook vastgesteld bij leraren met minder onderwijservaring dan bij leraren met meer onderwijservaring. Resultaten op de tweede onderzoeksvraag tonen aan dat in zowel de hoog als laag gepercipieerde lerende schoolcultuur (LO)-

scholen, leraren sneller ICT-specifiek ondersteuningsadvies (ASRs) geven aan elkaar wanneer ze ook algemeen pedagogisch advies geven aan elkaar, en vice versa. Het lijkt er dus op dat ondersteuningsrelaties (ASRs) rond pedagogische en ICT-specifieke kwesties voorkomen in alle scholen, en niet enkel in scholen gekenmerkt door een sterke lerende schoolcultuur. Anderzijds stelt deze studie ook vast dat in scholen met een hoge lerende schoolcultuur (LO), leraren minder snel ICT-specifiek advies zullen krijgen van die leraren waarvan ze pedagogisch advies krijgen in een wederkerige relatie. Het lijkt er dus op dat in deze hoog lerende schoolcultuur (LO) scholen, leraren voor hun ICT-specifiek advies best nieuwe ondersteuningsrelaties (ASRs) aangaan met andere collega's. De studie toont ook aan dat leraren die vaak gezocht worden voor pedagogisch advies en ICT-specifiek advies, ook een centrale positie innemen in de adviesnetwerken van hoog lerende schoolcultuur (LO)-scholen. Meer concreet neemt de centraliteit in het netwerk toe van deze leraren, naarmate de school als sterker wordt gepercipieerd als een lerende schoolcultuur. Leraren die tweekeer zoveel om pedagogisch advies worden gevraagd dan om ICT-specifiek advies, hebben minder kans op deze centrale positie in het ondersteuningsnetwerk van de school. Tegenovergesteld stelt de studie vast dat leraren die tweekeer zoveel om ICT-specifiek advies dan om pedagogisch advies worden gevraagd, meer kans hebben op deze centrale positie in het ondersteuningsnetwerk, en dit ongeacht het niveau van lerende schoolcultuur (LO). Deze bevindingen lijken te impliceren dat alle scholen nood hebben aan leraren met kennis en vaardigheden rond ICT die een centrale positie innemen in het ondersteuningsnetwerk van het schoolteam.

SUMMARY IN ENGLISH

The introduction of Information and Communication Technologies (ICT) in education has profoundly changed the way education is delivered in schools. Next to pedagogical innovations arising from the integration of ICT into the repertoire of teaching strategies applied by teachers in classroom environments, a major sociocultural transformation has been undergone in the organisational environment of schools. In the present dissertation, we address this transformation from a multidimensional perspective in Turkish public K-12 schools. For this purpose, we examine the multiple relationships between school principal's technology leadership (TL) practices, schools' learning organisation (LO) culture, and professional interactions among school actors, including school principals, vice-principals, ICT coordinators, and subject-field/grade-level teachers. While doing so, we control for the availability of ICT-enriched infrastructure in Turkish schools as a structural factor as well as teacher and principal demographics associated with ICT integration. For another important structural factor, we address the quality of internal ICT support in Turkish schools by developing a research instrument that is able to measure Turkish ICT coordinators' professional self-efficacy levels.

To clarify general connotations arising out of "sociocultural factors" and "structural factors"; school principals' TL practices are specified by the five standards of the International Society for Technology in Education for Administrators (ISTE-A) framework which is a well-known professional competency framework conducive to evaluate school principals' "visionary leadership", "digital-age learning culture", "excellence in professional practices", "systematic improvement", and "digital citizenship" standards. School's LO culture is considered a proxy for a positive school culture that promotes teachers' five professional learning orientations, which are "team learning", "shared vision", "systems thinking", "personal mastery", and "mental models" as suggested by the LO theory. Professional interactions are handled through technological and pedagogical advice-seeking relationships (ASRs) among school actors. While developing the research instrument, its items are constructed based on the performance indicators of the "National Competency Framework for ICT coordinators", which is an official report issued by Turkish Ministry of National Education.

This PhD dissertation includes four empirical studies, which are all reported in separate chapters. The first explores the predictive ability of school's LO culture as perceived by teachers to TL practices performed by school principals. To this end, data were collected using principal and teacher surveys from 58 school principals and 1105 teachers. A twofold research design is undertaken with the collected

data in order to answer two research questions: 1) In which profiles can school principals' TL practices be clustered?; and 2) To what extent are principals' demographic features, computer and internet usage, schools' existing LO culture and ICT infrastructure able to predict these TL profiles? For the first research question, latent class analysis (LCA) was employed to delineate school principals' TL practices within distinct sub-groups, i.e. latent profile structures. Each sub-group designates a TL profile whose members, i.e. school principals, reported similar features in relation to their self-report of performing ISTE-A standards. Our descriptive profile findings show reveal that nearly 55% of Turkish school principals are clustered under the high-level TL profile structure because they display greater self-report performance in overall TL practices; whereas 45% of those principals are classified into the low-level TL profile because of their relatively poor self-report performance. The most striking result emerging from the first study is that Turkish school principals are more likely to perform higher level TL practices if they manage an ICT-enriched school (Fatih school); use internet technology for a longer period of time a week, and manage a school in which teachers perceive a higher level of team learning professional learning orientation as part of school's LO culture.

The second empirical study uses the same data collection as the first study. However, partly switching the dependent and independent variables of the first study, this study investigates the predictive ability of school principals' TL practices to schools' LO culture as perceived by teachers on average, after controlling for the effect of other variables, like teacher gender, age, teaching experience by years, and school's educational stages, i.e. primary, middle and secondary school stages. The following two research questions are addressed in this study: 1) What are the distinct profiles of LO culture endorsed by teachers?, 2) To what extent are school principals' TL practices, teacher gender, age, years of experience, and school stage able to predict the emergent LO profiles? As a result, teachers' professional learning orientations as a proxy for school's LO culture are statistically clustered in three level LO profiles. Based on mean perception scores obtained from each profile, they are named as high, moderate and low level LO profiles. In the second stage, the emerging three-level LO profiles are regressed on school principals' TL practices. The findings from the logistic regression analysis indicate that teachers are more likely to perceive the high-level LO profile in schools where school principals reported higher level of performing "systemic improvement" standard in their TL practices. Besides, this study indicates that elderly teachers, and middle-school teachers, i.e. teaching 11-14 years old students, are more likely to perceive the high-level LO profile, compared to the moderate-level LO profile.

The third empirical study set out to develop a psychometric valid and reliable research instrument to assess Turkish ICT coordinators' professional self-efficacy. Specifically, this scale development study seeks to answer the following research question: Does the research instrument developed in this study yield an acceptable level of reliability and validity to measure ICT coordinators' professional self-efficacy? In answering this question, first, 53 draft items are generated by reviewing the "National Competency Framework for ICT Coordinators". Next, the content and face validity of these draft items was examined. For doing so, four scholars' expert opinion were asked about the draft items, who work in the Computer Instruction and Technology Education department of three Turkish universities. Based on their expert opinion, 8 items are excluded from the draft instrument. Later, the construct validity of the remaining items was verified by using sequentially principal component analysis (PCA) and confirmatory factor analysis (CFA). As a result, this study demonstrates that a seven-component solution with 34 items accounts for 65.90% of the total variance. After one item is eliminated because of high value of standardized residual, CFA yields the final seven-component solution with 33 items. As a result, the developed measurement instrument appeared to be psychometrically sound for measuring Turkish ICT coordinators' professional self-efficacy levels. The emerging seven components were named in accordance with the seven competency fields described by TMONE (2008), such as 'mastery of instructional design', 'using ICT-related concepts properly', 'measurement and evaluation tools', 'hardware and software equipment', 'multimedia applications', 'instructional software', and 'safe and ethical ICT use'. As for test-retest procedure, the research instrument was administered to 67 pre-service ICT coordinators with two weeks interval. Test-retest reliability was used to confirm the developed instrument's time invariance. At last, the developed research instrument was administered to 53 in-service ICT coordinators. The results of variance analysis (t-test) revealed that female ICT coordinators had higher professional self-efficacy levels in 'instructional design', 'hardware and software mastery', 'measurement and evaluation', 'safe and ethical ICT use' competency fields than their male counterparts.

The fourth empirical study addresses technological and pedagogical ASRs that teachers develop with other teachers, school principals, vice-principals etc. In its research design, individual (micro-level), relational (meso-level), and school-related (macro-level) factors are taken into consideration as they are able to influence ASRs among teachers. Afterwards, the interrelatedness of technological and pedagogical ASRs are compared between those schools with a high and low level LO culture. To this

end, the fourth study is guided by two research questions: 1) To what extent do micro (i.e. gender, age, experience, departmental or administrative assignments), meso (interpersonal similarity of these features), and macro level factors (i.e. average teacher experience and perception of LO culture in schools) account for technological and pedagogical ASRs?; and 2) Which structural effects are associated with the relatedness of technological and pedagogical ASRs in distinct school contexts where teachers perceive high-level and low-level LO culture? The p2 and exponential random graph models (ERGMs) are two advanced social network analysis (SNA) approaches, which are separately used in this study to answer these two research questions. The results indicate that male teachers have more tendencies to provide pedagogical and technological ASRs to colleagues than their female counterparts. Teachers with the same gender, similar years of experience at the current school, and teaching the same subject-fields are more likely to contact each other for technological and pedagogical ASRs. This study also concludes that pedagogical ASRs are more likely to occur between administratively superior teachers and their subordinates. Furthermore, technological and pedagogical ASRs occur more reciprocally between teachers positioned within the same administrative rank (i.e. teacher-to-teacher, vice-principal-to-vice-principal). Contrastingly, these ASRs are more likely to become one-sided between teachers who teach different subject fields. Besides, the more the average age of teachers increases in a school, the less teachers engage in pedagogical ASRs with colleagues in that school. One of the most important findings show that teachers' perception of the high-level LO culture increase the likelihood of pedagogical ASRs among teachers. In other words, teachers are more likely to establish pedagogical ASRs in the schools where they perceived a higher level of LO culture on average. For the second research question, we compare the patterns of ASRs between two groups of schools with the high and low-level perceived LO culture. If a pattern of ASR proved to be significant in both groups, it means that this pattern is evident regardless of the LO culture. The results from the second research question reveals that, regardless of the perceived LO culture, teachers are more likely to seek technological advice from a colleague to whom they give pedagogical advice, and vice versa. This means that give-and-take type of ASRs are prevalent independently of the perceived LO culture in schools. On the other hand, in the schools endowed with the high-level LO culture, teachers are less likely to receive technological advice from colleagues with whom they exchange pedagogical advice in a reciprocal way. That is, this study discloses that LO culture appears to push the boundaries of conventional give-and-take exchanges by encouraging teachers to contact other colleagues for

technological ASRs with whom they are not already in contact for pedagogical ASRs. Besides, teachers who are equally sought out for both technological and pedagogical ASRs are more likely to occupy a central position on advice networks in schools with the high-level LO culture. To put differently, the popularity of teachers who provide both technological and pedagogical ASRs to equal number of colleagues increases in schools where much more teachers perceive the high-level LO culture on average. The teachers who are asked for pedagogical advice by twice as many colleagues as technological advice are less likely to occupy a central position on advice networks in schools with the high-level LO culture. On the contrary, the teachers who are asked for technological advice by twice as many colleagues as pedagogical advice, so to say tech-savvy teachers, are more likely to occupy a central position in the advice networks, but irrespective of the perceived LO culture in schools. These findings, coupled with the previous findings, imply that LO culture appears to undermine the popularity (i.e. higher number of in-coming tie) of pedagogical advice givers, while technological advice-givers are already more popular than others to be sought out for ASRs in general. At last, this study reveals that the two teachers who are specifically sought out for technological advice by the same group of colleagues were more likely to give or receive, i.e. one-sided, pedagogical advice from each other in general. In other words, popular tech-savvy teachers are more likely to collaborate with each other, irrespective of the school's LO culture.

ÖZET (SUMMARY IN TURKISH)

Bilişim teknolojileri (BT) araçlarının eğitim süreçleriyle daha fazla bütünleşmesi okullarda verilen eğitimde köklü değişimlere yol açmıştır. BT araçlarının öğretmenlerin sınıf ortamında uyguladıkları öğretim stratejileri üzerindeki pedagojik anlamda inovatif etkisinin yanı sıra, BT ile bütünleşme okul ortamındaki örgütsel ilişkilerde de önemli sosyokültürel dönüşümlere yol açmıştır. Bu doktora tezi okulların BT ile bütünleşmesiyle birlikte ortaya çıkan sosyokültürel değişimleri Türkiye'deki devlet okulları özelinde çok yönlü olarak ele almak amacıyla yürütülmüştür. Bu amaca yönelik olarak okul müdürlerinin teknoloji liderliği (TL) davranışları, okulların öğrenen örgüt (ÖÖ) kültürü ve okul müdürü, müdür yardımcıları, BT koordinatörleri ve branş/sınıf öğretmenleri arasındaki mesleki etkileşimler incelenmiş; bu üç değişken arasındaki ilişkiler mercek altına alınmıştır. Bu incelemeler sırasında okulların BT alt-yapı olanakları BT ile bütünleşmelerinin yapısal bir etkeni olarak istatiksel olarak kontrol edilmiştir. Benzer şekilde bazı öğretmen ve okul müdürü demografik bilgileri de istatiksel anlamda kontrol altına alınmıştır. Okulların BT ile bütünleşmesini etkileyen bir diğer yapısal etken olan okul-içi BT desteği hizmetinin niteliği de bu tezde ele alınmış ve BT koordinatör öğretmenlerinin mesleki öz-yeterlik düzeylerini ölçen Türkçe bir ölçek geliştirilmiştir.

Sosyokültürel ve yapısal etken ifadelerinden doğabilecek anlam belirsizliğini azaltmak ve bu etkenlerin somut göstergelerin ortaya koymak için, okul müdürlerinin TL davranışları bu davranışların dünya çapında bilinirliği olan ISTE-A standartlarına uygunluğu açısından incelenmiştir. Okul müdürlerinin TL davranışlarının göstergesi olarak değerlendirilen beş ISTE-A standardı okul müdürlerinin vizyoner liderlik, dijital-çağ öğrenme kültürü, mesleki gelişimde mükemmellik, sistem geliştirme, dijital vatandaşlık mesleki yeterliklerini içermektedir. Okulun ÖÖ kültürü öğretmenlerin mesleki gelişimine katkı sağlayan olumlu bir okul kültürü olarak tanımlanmıştır. Okulun ÖÖ kültürünün göstergeleri olarak öğretmenlerin takım halinde öğrenme, paylaşılan vizyon, sistem düşüncesi, kişisel hakimiyet ve zihinsel model geliştirme mesleki öğrenme yönelimleri incelenmiştir. Öğretmenler arasındaki mesleki etkileşimler, teknoloji ve pedagojik konularda aralarındaki tavsiye alma ilişkileri (TAİ) ele alınarak incelenmiştir. Geliştirilen ölçeğin maddeleri oluşturulurken BT koordinatörlerinin mesleki yeterliklerinin göstergeleri olarak Milli Eğitim Bakanlığı tarafından geliştirilen "BT Öğretmeni Özel Alan Yeterlikleri" belgesindeki performans göstergelerinden yararlanılmıştır.

Yürütülen doktora çalışması 4 empirik araştırmaya dayanmakta olup, her araştırma ayrı bir bölüm olarak raporlaştırılmıştır. İlk empirik araştırma okulların ÖÖ kültürünün okul müdürlerinin TL davranışlarını

yordama yeterliğini incelemektedir. Bu amaca yönelik olarak 58 okul müdürü ve bu müdürlerin görev yaptığı okullarda çalışan 1105 öğretmenden veri toplanmıştır. Toplanan veriler iki aşamalı bir analiz yaklaşımıyla incelenmiş ve bu yolla şu araştırma sorularına cevap aranmıştır: 1) Gerçekleştirdiklerini ifade ettikleri TL davranışlarına göre okul müdürleri kaç farklı profile ayrılabilir? 2) Ortaya çıkartılan TL profilleri öğretmenler tarafından algılanan mevcut ÖÖ kültürü seviyesi, okul müdürlerinin cinsiyeti, yaşı, haftalık bilgisayar ve internet kullanma süreleri değişkenleri tarafından ne ölçüde yordanabilir? İlk araştırma sorusuna yönelik analizlerde, okul müdürlerini gösterdikleri benzer TL davranışlarına göre kategorilere ayırmak için örtük sınıf analizi (ÖSA) kullanılmıştır. İki kategoride toplanan müdürlerin ISTE-A standartlarına göre TL davranış örüntülerinin özgün bir profil oluşturduğu ve her bir müdürün kendi kategorisindeki diğer müdürlerle TL profillerinin benzerlik gösterdiği tespit edilmiştir. ISTE-A standartlarına göre TL davranış düzeylerine bakıldığında, okul müdürlerinin yüksek ve düşük düzey profil olmak üzere iki tipte TL davranışı sergiledikleri ortaya çıkartılmıştır. Profillere ait tanımlayıcı istatistikler okul müdürlerinin yaklaşık %55'inin yüksek düzey TL profilinde kümelendiği, ancak geriye kalan %45'inin düşük düzey TL profilinde örüntülenen TL davranışlarını sergiledikleri tespit edilmiştir. İkinci araştırma sorusunun lojistik regresyon analizi ile incelenmesinden ortaya çıkan sonuçlar okul müdürlerinin yüksek düzey TL davranışları sergilemesinde: a) okullarının Fatih projesi tarafından sağlanan BT alt-yapısına sahip olması, b) haftalık internet kullanma sürelerinin daha fazla olması, c) görev yaptıkları okullarda ÖÖ kültürünün öğretmenler tarafından daha yüksek düzeyde algılanması değişkenlerinin etkili olduğu görülmüştür.

İkinci empirik araştırmanın amacı, birinci araştırmanın tersi yöndeki yordayıcılık ilişkisine odaklanarak, okul müdürlerinin TL davranışlarının öğretmenlerin algıladığı ÖÖ kültürünü yordama yeterliğini incelemektedir. İkinci araştırmada kullanılan veri kaynağı birinci araştırma ile aynıdır (i.e. 1105 öğretmen ve 58 okul müdürü). Ancak analitik açıdan ilk çalışmadan farklı olarak incelenen yordayıcı ve yordanan değişkenlerin yerleri değiştirilerek analize dâhil edilmiştir. Ayrıca öğretmenin cinsiyeti, yaşı, okulundaki yıl olarak öğretmenlik deneyimi, ve okulun eğitim kademesi kontrol değişkenleri olarak analizlere dâhil edilmiştir. Bu çalışmada iki araştırma sorusuna cevap aranmıştır: 1) Okullarında algıladıkları ÖÖ kültürüne göre öğretmenler kaç farklı profile ayrılabilir? 2) Ortaya çıkan ÖÖ kültürü profilleri okul müdürlerinin TL davranışları, öğretmenin cinsiyeti, yaşı, okulundaki öğretmenlik deneyimi ve okulun eğitim kademesi değişkenleri tarafından ne ölçüde yordanabilir? Profillere ait tanımlayıcı istatistikler öğretmenlerin sahip oldukları mesleki öğrenme eğilimlerine göre üç tip ÖÖ kültürü profilinde kümelendiği

görülmüştür. Her profildeki öğretmenlerin mesleki öğrenme eğilimi göstergeleri birbirinden farklı seviyelerde profiller oluşturduğu için ÖÖ kültürü profilleri düşük, orta ve yüksek düzey profiller olarak adlandırılmıştır. İkinci araştırma sorusunun lojistik regresyon analizi ile incelenmesinden ortaya çıkan sonuçlar öğretmenler tarafından yüksek düzey ÖÖ kültürünün algılanmasında: a) okul müdürlerinin "sistem geliştirme" standardına uygun daha yüksek düzeyde TL davranışı sergilemesi, b) öğretmenin daha ileri yaşta olması, c) ortaokul kademesindeki bir okulda görev yapıyor olması değişkenlerinin yordayıcı olduğu görülmüştür.

Üçüncü empirik araştırma bir ölçek geliştirme çalışmasıdır. Bu araştırmada BT koordinatörlerinin mesleki öz-yeterlik seviyelerini ölçebilen, psikometrik açıdan geçerli ve güvenilir bir ölçme aracı geliştirmek amaçlanmıştır. Bu amaca yönelik olarak şu araştırma sorusuna cevap aranmıştır: Geliştirilen ölçme aracı BT koordinatörlerinin mesleki öz-yeterlik seviyesinin ölçülmesinde ne ölçüde geçerli ve güvenilir sonuçlar vermektedir? Bu soruya cevap bulmak için Milli Eğitim Bakanlığı tarafından geliştirilen mesleki yeterlik performans göstergeleri kullanılarak 53 taslak ölçek maddesi oluşturulmuştur. Taslak ölçek maddelerinin kapsam ve görünüş geçerliğini sınamak için 53 taslak madde 3 farklı üniversiteden 4 BT Öğretmenliği Bölümü öğretim üyesinin uzman görüşüne sunulmuştur. Uzman görüşlerine bağlı olarak 8 madde taslak formdan çıkartılmıştır. Ardından kalan 45 maddelik taslak ölçme aracının yapısal geçerliğini sınamak için 190 hizmet öncesi BT öğretmeninden bu araçla veri toplanmıştır. Verilerin analizinde sırasıyla temel bileşenler analizi ve doğrulayıcı faktör analizi kullanılmıştır. Temel bileşenler analizi sonucunda 34 madde ve 7 boyuttan oluşan ölçme aracının oluşan toplam varyansın %65.90'ını açıklayabildiği tespit edilmiştir. Sonrasında gerçekleştirilen doğrulayıcı faktör analizinde 1 maddenin yüksek standardize edilmiş artık değer (standardized residual) nedeniyle taslak formdan çıkartılması sonucunda, 33 madde ve 7 boyuttan oluşan nihai ölçme aracı formunun kabul edilebilir model-veri uyumu göstergelerine sahip olduğu görülmüştür. Ölçme aracının boyutları Milli Eğitim Bakanlığı tarafından geliştirilen BT öğretmeni yeterlik alanlarına dayanılarak şu şekilde isimlendirilmiştir: öğretim tasarımı, BT kavramlarını doğru şekilde kullanabilme, ölçme ve değerlendirme, donanım ve yazılım bilgisi, multimedya uygulamaları, öğretim yazılımları, güvenli ve etik BT kullanımı. Son olarak geliştirilen ölçme aracı 53 BT koordinatörüne uygulanarak betimsel istatistikler ve varyans analizi aracılığıyla incelenmiştir. Sonuç olarak BT koordinatörlerinin "güvenli ve etik BT kullanımı" boyutunda kendilerini en yüksek düzeyde yeterli gördükleri, ancak "multimedya uygulamaları" boyutunda en az düzeyde öz-yeterlik algısına sahip oldukları belirlenmiştir. Ayrıca kadın BT koordinatörlerinin "öğretim tasarımı",

“donanım ve yazılım bilgisi”, “ölçme ve değerlendirme”, güvenli ve etik BT kullanımı” boyutlarında kendilerini erkek meslektaşlarından daha fazla yeterli gördükleri tespit edilmiştir.

Dördüncü ve son empirik araştırmada eğitimcilerin kendi aralarındaki mesleki etkileşimleri teknolojik ve pedagojik konularda birbirlerinden tavsiye alma ilişkileri (TAİ) bağlamında incelenmiştir. Araştırma deseninde bireysel değişkenler (cinsiyet, yaş, yıl olarak öğretmenlik deneyimi, varsa yöneticilik görevi, varsa zümre başkanlığı görevi), iki öğretmen arasındaki ilişkisel değişkenler (cinsiyet farkı, yaş farkı, yıl olarak öğretmenlik deneyimi farkı, yöneticilik pozisyonu farkı, zümre başkanlığı pozisyonu farkı, branş/okutulan sınıf farkı) ve örgütsel değişkenler (okuldaki öğretmenlerin ortalama öğretmenlik deneyimi, okulun ortalama ÖÖ kültürü seviyesi) bir arada incelenmiştir. Bu incelemeler sonucunda şu iki araştırma sorusuna cevap aranmaya çalışılmıştır: 1) Bireysel, ilişkisel ve örgütsel değişkenler okul içerisindeki teknolojik ve pedagojik TAİ’yi ne olasılıkta yordayabilmektedir? 2) Yüksek ve düşük düzey ÖÖ kültürüne sahip okullarda hangi farklı yapısal etkenler teknolojik ile pedagojik TAİ’nin birbirleriyle olan bağını etkilemektedir? Bu incelemeleri yapabilmek için sosyal ağ analizinin, bildiğimiz kadarıyla Türkiye’de daha önce hiç kullanılmayan, ileri düzey iki uygulaması p2 ve ERGM modelleri kullanılmıştır.

İlk araştırma sorusuna yönelik bulgular erkek öğretmenlerin kadın meslektaşlarından anlamlı düzeyde daha yüksek olasılıkla teknolojik ve pedagojik konularda tavsiye verme eğiliminde olduğunu göstermiştir. Aynı cinsiyette, okuldaki öğretmenlik deneyimleri yıl sayısı olarak birbirine daha yakın, ve aynı branştan öğretmenlerin birbirleriyle teknolojik ve pedagojik TAİ kurma olasılığının anlamlı düzeyde daha yüksek olduğu görülmüştür. Yöneticiler ile öğretmenlerin aralarında pedagojik TAİ kurma olasılığının anlamlı düzeyde yüksek olduğu bulunmuştur. Ancak bu ilişkide okul müdürleri ve müdür yardımcılarının anlamlı düzeyde yüksek olasılıkla sadece tavsiye veren olduğu tespit edilmiştir. Karşılıklı tavsiye alışverişinin aynı pozisyondaki, yani müdür yardımcıları arasında ve öğretmenlerin kendi aralarında oluşma olasılığının anlamlı düzeyde daha yüksek olduğu bulunmuştur. Öte yandan farklı branşlardan olan ya da farklı sınıfları okutan öğretmenler arasında tek-yönlü TAİ’nin, i.e. sadece tavsiye alma ya da sadece tavsiye verme eğilimi, anlamlı düzeyde yüksek olasılıkla görüldüğü tespit edilmiştir. Önemli bulgulardan bir tanesi, yüksek düzeyde ÖÖ kültürüne sahip okullarda pedagojik konularda karşılıklı TAİ’nin görülme olasılığının düşük düzeyde ÖÖ kültürüne sahip okullara kıyasla anlamlı düzeyde daha yüksek olduğunu göstermiştir. Diğer bir ifadeyle okulun ÖÖ kültür düzeyinin eğitimciler arasında eğitim-öğretimi ilgilendiren konularda karşılıklı tavsiye alışverişini kuvvetlendirdiği tespit edilmiştir. Aynı eğilimin öğretmenlerin kendi okullarında geçirdikleri öğretmenlik deneyimi süresinin

ortalaması azaldığında da görüldüğü belirlenmiştir. Diğer bir ifadeyle, örneğin yeni açılmış bir okulda, kısa bir süredir eğitim veren bir okulda ya da eski bir okul olmasına rağmen okul kadrosunu büyük oranda yenilemiş bir okulda karşılıklı pedagojik TAİ'nin görülme olasılığının daha yüksek olduğu bulunmuştur.

İkinci araştırma sorusuna yönelik bulgularda, okulun ÖÖ kültür seviyesinden bağımsız olarak, tüm okullarda öğretmenlerin teknolojik tavsiye alırsa karşılığında anlamlı düzeyde yüksek olasılık pedagojik tavsiyede bulunduğunu ya da, tam tersine, pedagojik tavsiye alırsa karşılığında yüksek olasılıkla teknolojik konularda tavsiye verdiğini ortaya koymuştur. Benzer şekilde okulun ÖÖ kültür seviyesinden bağımsız olarak tüm okullarda, bir eğitimciyle teknolojiyle ilgili konularda kurulan TAİ ilişkisinin pedagojik konularda kurulanın iki katı olmasının o eğitimciyi anlamlı düzeyde daha yüksek olasılıkla okulda en fazla TAİ ilişkisi kurulan kişi pozisyonuna getirdiği görülmüştür. Diğer bir ifadeyle, bir eğitimcinin teknolojik konularda tavsiye alınmak üzere fazla kişi tarafından tercih edilmesinin, bir öncekinin yarı oranında meslektaşı tarafından da olsa, pedagojik konularda da tavsiye alınabilir insan konumuna getirdiği bulunmuştur. Ancak yüksek düzeyde ÖÖ kültürüne sahip okullarda, bir eğitimciyle pedagojiyle ilgili konularda kurulan TAİ ilişkisinin teknolojik konularda kurulanın iki katı olmasının anlamlı düzeyde düşük olasılıkta olduğu görülmüştür. Bu sonuç, yüksek ÖÖ kültürüne sahip okullarda eğitimcilerin pedagojik konularda yüksek oranda tercih edilir olmasının onları, daha az oranda bile olsa, teknolojik konularda da tavsiyesine başvurulabilir kişi konumuna getirmediğini göstermektedir. Yüksek düzeyde ÖÖ kültürüne sahip okullarla ilgili bir diğer sonuç, bu okullarda hem teknolojik hem de pedagojik konularda aynı kişiyle TAİ ilişkisi kurma olasılığının ve bu kişinin okulda daha fazla insan tarafından TAİ için tercih edilme olasılıklarının anlamlı düzeyde daha yüksek olduğu bulunmuştur. Yine yüksek düzeyde ÖÖ kültürüne sahip okullarda karşılıklı pedagojik TAİ kuran kişilerden birinin aynı zamanda teknolojik TAİ kurma olasılığının anlamlı düzeyde düşük olduğu belirlenmiştir. Buna karşılık, düşük ÖÖ kültürüne sahip okullarda karşılıklı teknolojik TAİ ilişkisi kuran eğitimcilerden birini aynı zamanda pedagojik konularda da TAİ kurma olasılığının anlamlı düzeyde daha yüksek olasılıkta olduğu görülmüştür. Son olarak, okulda hissedilen ÖÖ kültüründen bağımsız olarak tüm okullarda, teknoloji ile ilgili konularda bir grup meslektaşı tarafından tavsiyesine başvurulan iki eğitimciden birinin diğeri ile aynı zamanda pedagojik TAİ ilişkisi kurma olasılığının anlamlı düzeyde yüksek olduğu görülmüştür.

ACADEMIC OUTPUT

Journals (A1-Web of Science)

Banoğlu, K., Vanderlinde R., & Çetin, M. (*2016*). Investigation of principals' technology leadership profiles in the context of schools' learning organization culture and ICT infrastructure: F@tih project schools vs. the others. *Education and Science*, *41*(188),83-98.

Banoğlu, K., Vanderlinde, R., & Yıldız, R. (2015). Professional self-efficacy scale for ICT teachers. *Anthropologist*, 20(1-2), 22–32.

Banoğlu, K., Vanderlinde R., & Çetin, M. (Under review). Who chooses whom for professional ınteraction? A sociometric ınquiry into the relatedness of technological and pedagogical advice-seeking relationships among teachers. *Sociology of Education*.

Book Chapter (B2)

Banoğlu, K., Vanderlinde, R., Çetin, M., & Aesaert, K. (Under review). Role of principals' technology leadership practices in shaping learning organization culture: In pursuit of the creative tension. I*nternational Handbook for Governance, Leadership, Administration and Management in Education*. Springer Publisher.

DATA STORAGE FACT SHEET

% Name/identifier study: Multivariate analysis of school principals' technology leadership competencies, learning school environment and schools' social network structures

% Author:Köksal Banoğlu

% Date:01/10/2019

1. Contact details

==========

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2. Information about the datasets to which this sheet applies

==========

* Reference of the publication in which the datasets are reported:

Banoğlu, K. (2019). Multivariate analysis of school principals' technology leadership competencies, learning school environment and schools' social network structures. Unpublished Doctorate Dissertation. Ghent University, BE; Marmara University, TR.

* Which datasets in that publication does this sheet apply to?:

- Teacher dataset
- School principal dataset
- ICT coordinator dataset
- School network datasets (9 sets)

3. Information about the files that have been stored

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3a. Raw data

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* Have the raw data been stored by the main researcher? [X] YES / [ ] NO

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3b. Other files
SPSS Analysis Outputs, MPlus Analysis Outputs
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